

# PC

The Independent Guide to  
IBM Personal Computers

Volume 2      Number 4  
September 1983      \$2.95

# THE ART & ALCHEMY OF PROGRAMMING

8087: FAST MATH

Speech  
Synthesizers  
Realized

Software  
Superstars

TK! Solver  
Reviewed

The Future  
of BASIC

The Mythical  
Man-Month

10 Languages:  
Which Is Best?

Welcome  
Peter  
Norton





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that the most powerful word processing package  
ever created for the IBM® Personal Computer  
wasn't created by IBM.

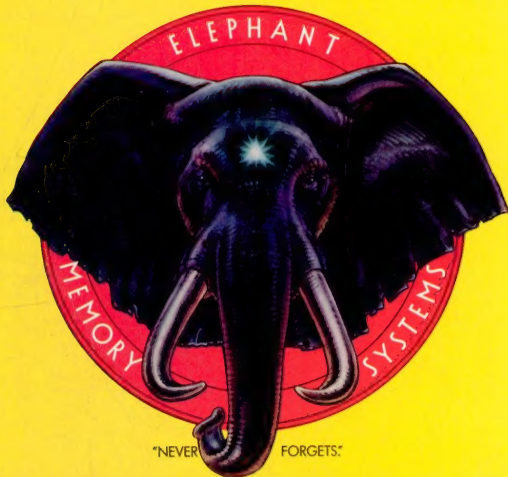
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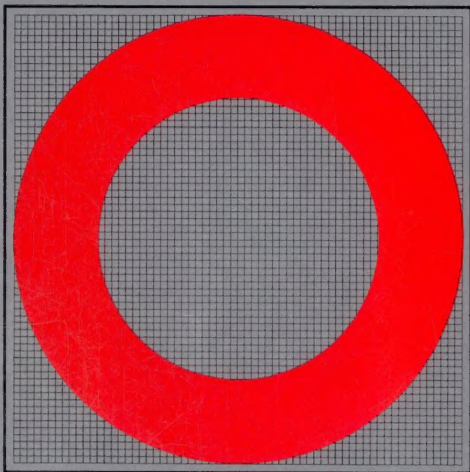
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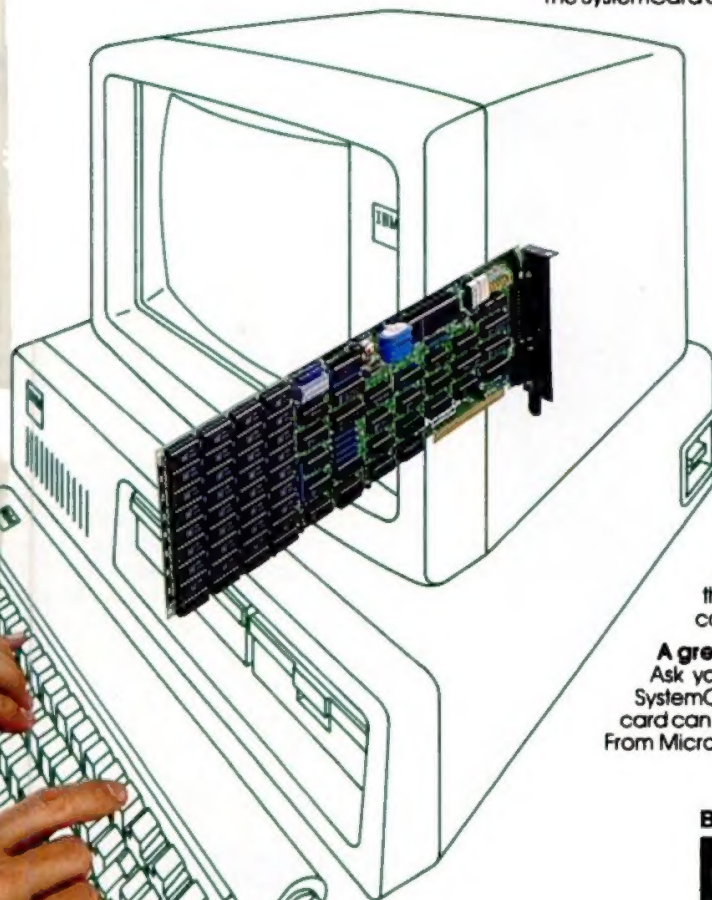
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This One



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BETTER TOOLS FOR MICROCOMPUTERS

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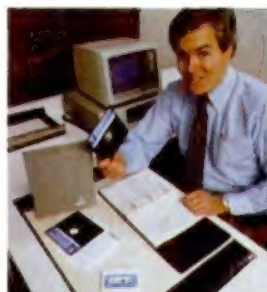
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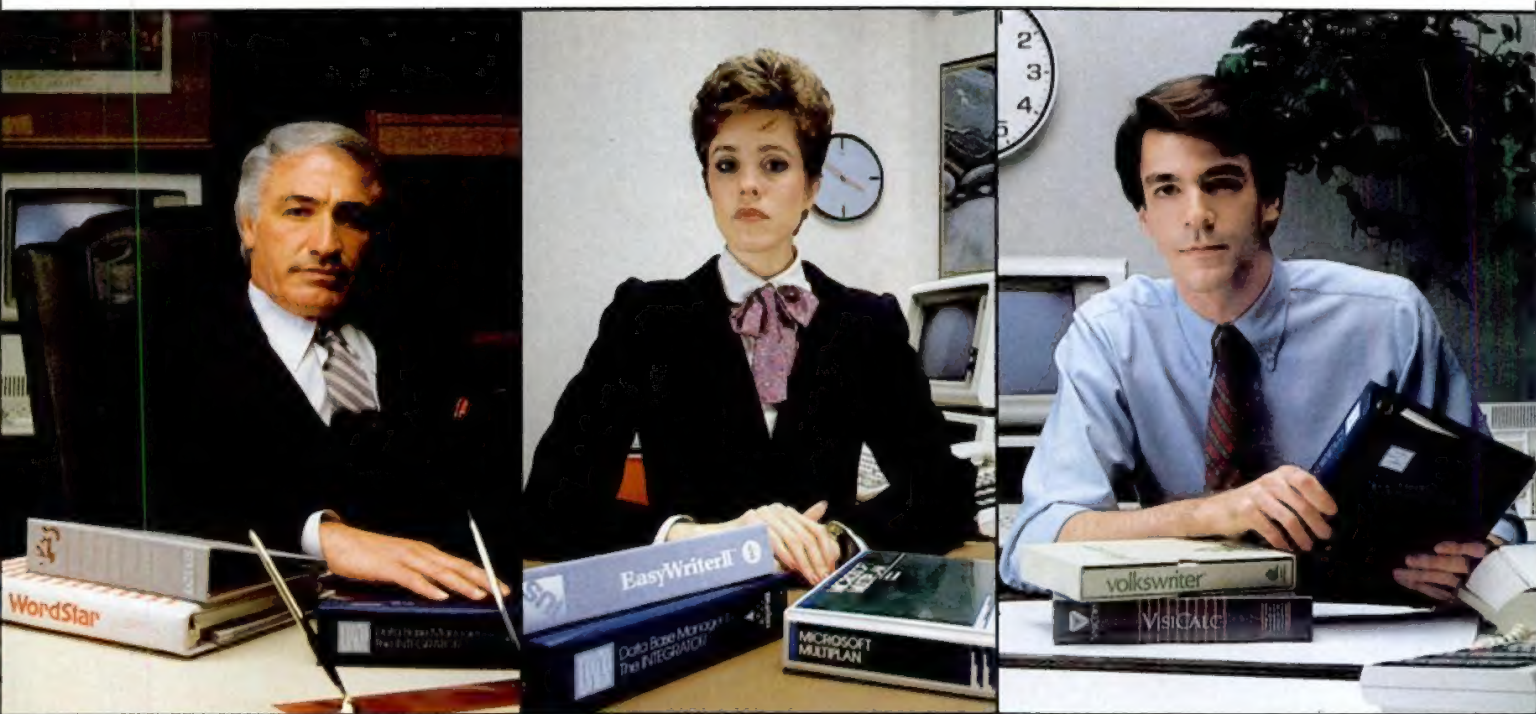
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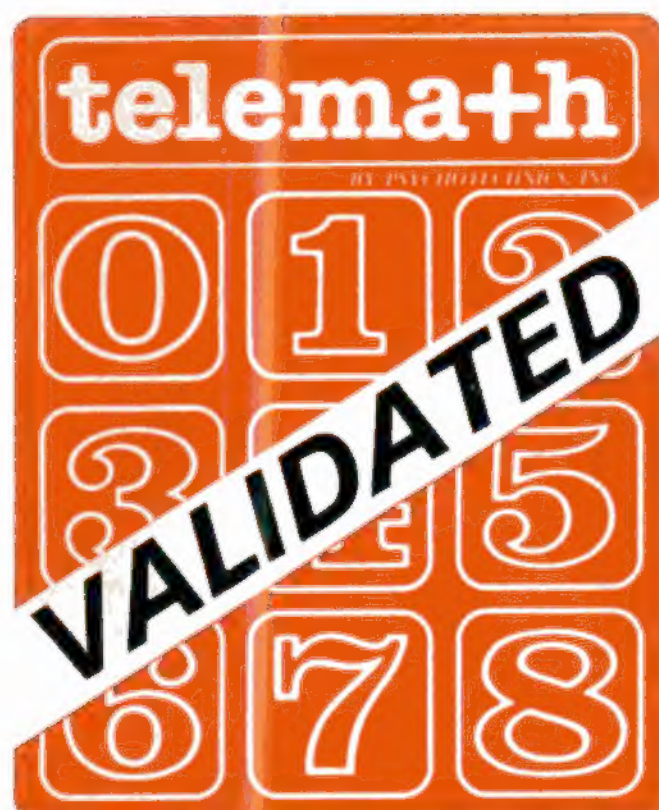


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**The Independent Guide to  
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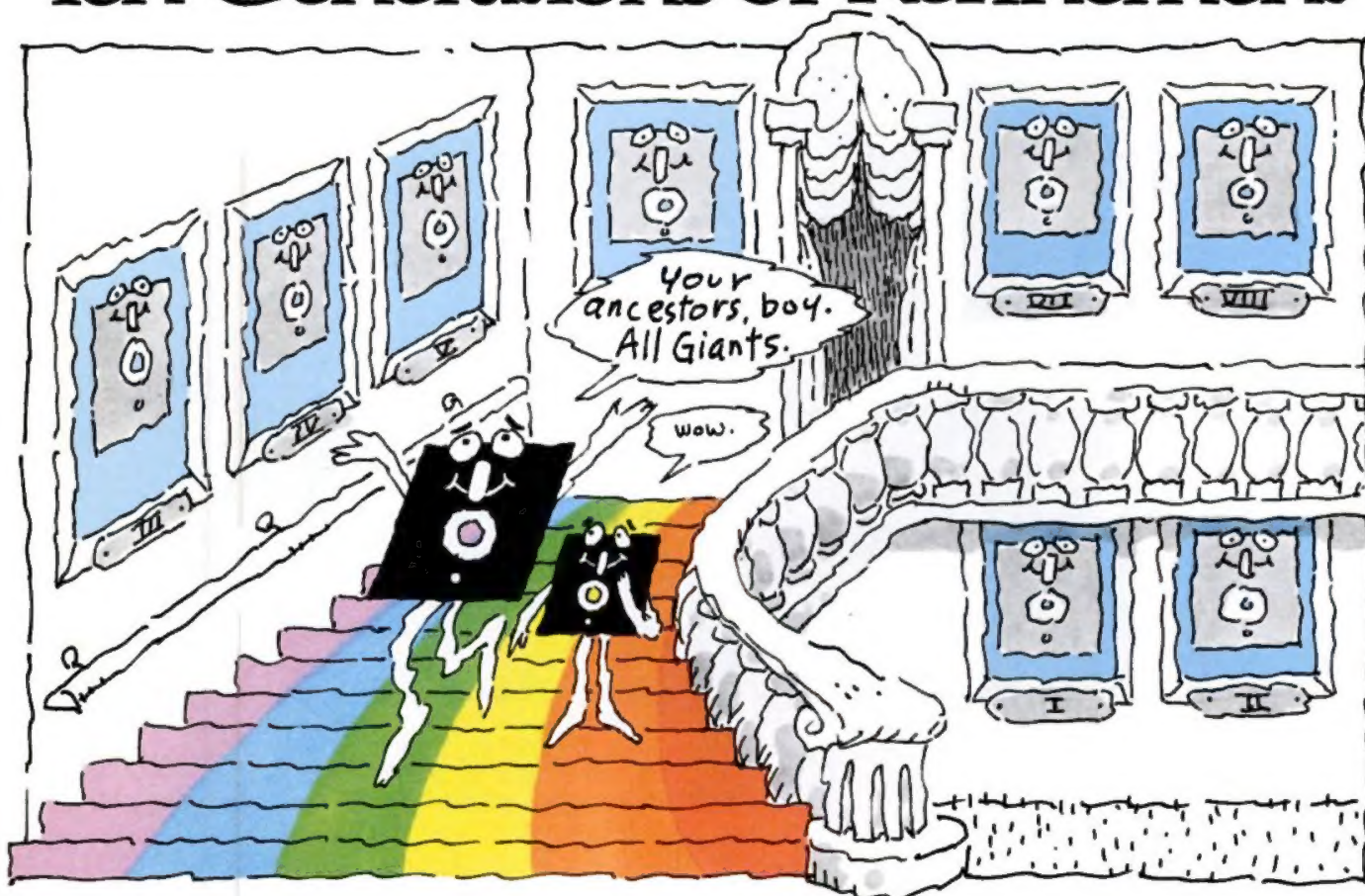
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IBM Personal Computers

September 1983  
Volume 2  
Number 4



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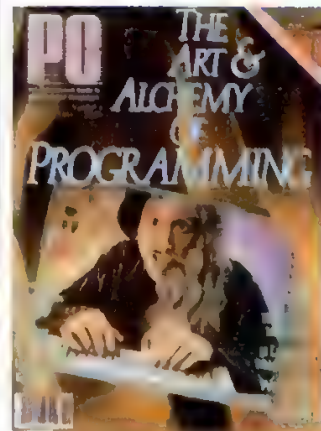
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## **COVER**

Photography by Dennis Bettencourt





# It took hundreds of years to build the world's most advanced spreadsheet.

Way back in 1534, a Venetian scholar wrote a text that standardized the techniques of modern bookkeeping. And up till 1979, there weren't a lot of real improvements in the way people did spreadsheets. You still had to enter all your figures by hand. Run all the totals yourself. And when you had to make a few changes, you had to run the totals all over again.

Then along came a program that let you create spreadsheets on a personal computer. Without touching a pencil. Or adding anything by hand. Best of all, this new program gave you the freedom to look at your balance sheet a dozen different ways if

you felt like it. Because all you had to do was change one figure, and the computer would refigure everything else for you. Automatically.

Like most breakthrough ideas though, this original spreadsheet program had a few things that definitely needed improvement. For instance, all the columns had to be the same width. And the entire system took about 20 hours to learn.

So we developed SuperCalc®, which was such a giant step in the

right direction that it became a best-seller. Over 250,000 copies in only 18 months.

Today, we've gone even farther. After talking with thousands of customers, we've found a lot of important new features you'd like to have. And we've built them into the world's most advanced spreadsheet.

SuperCalc®.

## 1534

1540 Admimo Pib

194	Pro et danno // A donu varij, per lo tratto in resto, per saldo di quello 37
195	Pro et danno // A Spese de uuer di spese fatte, come in esse appar, per saldo 1548 20 P 14
196	Fatti della possessione da Moran // A per filo di quella per l'anno presente, 1541, per saldo de quelli 37 45 8
197	Pro et danno // A Spese diuerse per l'anno presente, come in esse appar, per 1599 8 12 P
198	Pro et danno // A Spese de salariati piu spese fatte l'anno presente, come per saldo di quelle 37 48 8 12 P
199	Pro de zeccha in monte // A Pro et d lita seguita, come in quello appar, per 1550 8 P
200	Pro et danno // A Caudal de me Alun

## 1979

STATEMENT			
	JAN 1980	FEB 1980	MAR 1980
SALES			
COST	300	330	
GROSS	700	770	
R & D	160	176	
MARKETING	200	224	
ADMIN.	140	151	
TOTAL	500	551	
INCOME	200	219	
TAXES	80	88	
NET	120	131	

## 1981

INCOME STATEMENT	
NET SALES	1
COST OF GOODS SOLD	
GROSS PROFIT	
RESEARCH & DEVELOPMENT	
MARKETING	
ADMINISTRATIVE	
TOTAL OPERATING EXPENSES	
INCOME BEFORE TAXES	
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1983

Combines  
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Calendar/date  
capabilities.

Percentages.

## COMPANY CONSOLIDATED MONTHLY PAYROLL

Today's Date	4/15/83	Deduction Percentages				
Payroll Start Date	4/ 1/83	Fica	6.700%			
Days this period	15	SDI	8%			
Recalculate YTD Y/N ?	N	User-set decimal places.				
Emp#	Employee name	Status	Gross Salary	Total Deduct	Net Pay	YTD Gross
34	Adams	M	\$1,100.00 ( \$82.50)	\$1,017.50	\$6,200.00	
49	Bequette	S	\$750.00 ( \$56.25)	\$693.75	\$5,250.00	
84	Johnson	S	\$850.00 ( \$63.75)	\$786.25	\$5,950.00	
92	Jones	M	\$900.00 ( \$67.50)	\$832.50	\$6,300.00	
12	Samson	S	\$560.00 ( \$42.00)	\$518.00	\$3,920.00	
19	Santos	M	\$650.00 ( \$48.75)	\$601.25	\$4,550.00	
45	Smith	S	\$700.00 ( \$52.50)	\$647.50	\$4,900.00	
=====						
Total # employees	7	Floating \$ signs.		Embedded commas.		
Total Gross Salaries (100's)			\$55.1	Negative numbers in ( ).		
Total Deductions (100's)			\$-4.1			
Total Net Pay (100's)			\$51.0			

Arrange reports  
numerically or  
alphabetically,  
like this

Numbers in 100s or 1000s.

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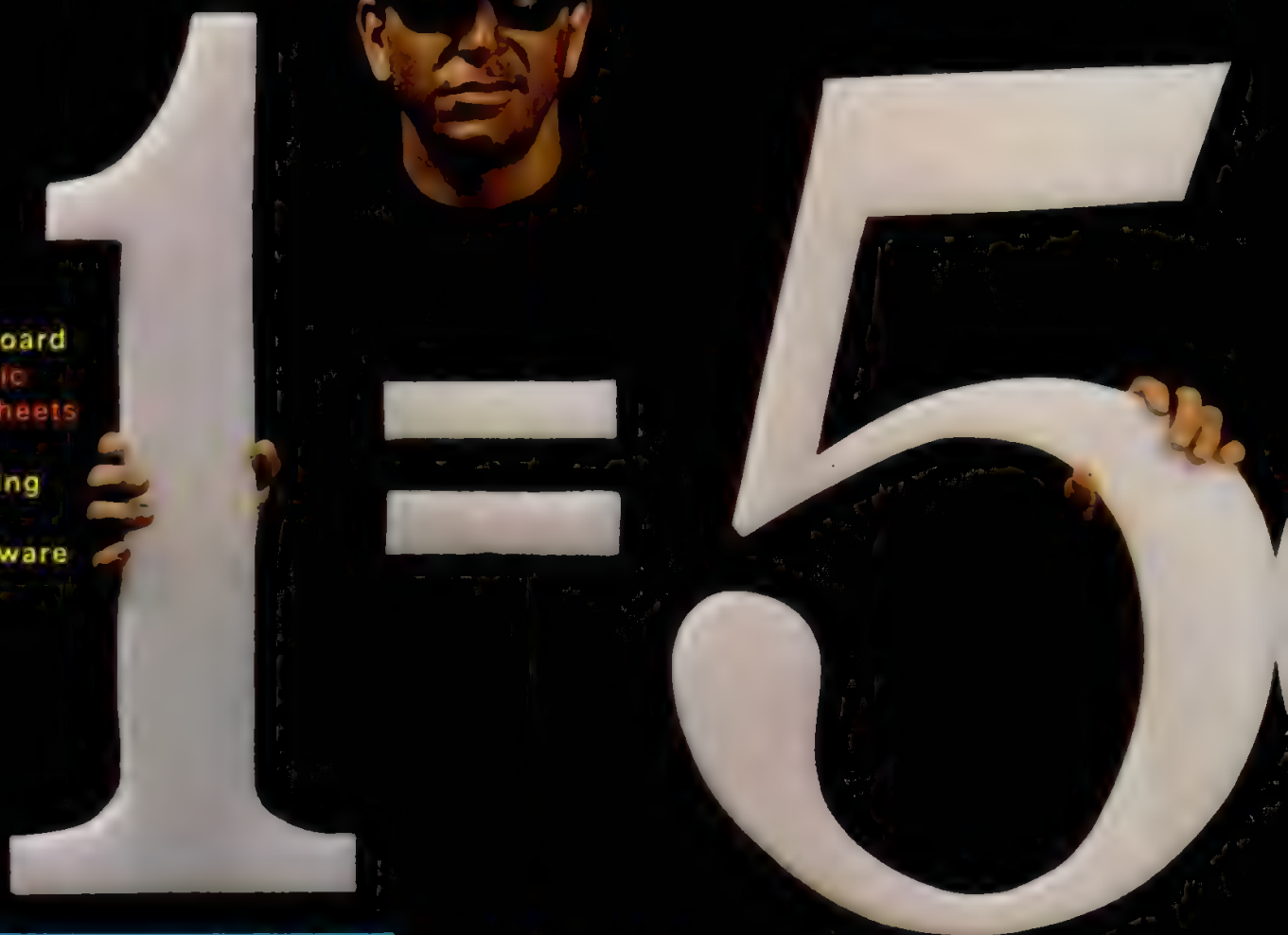
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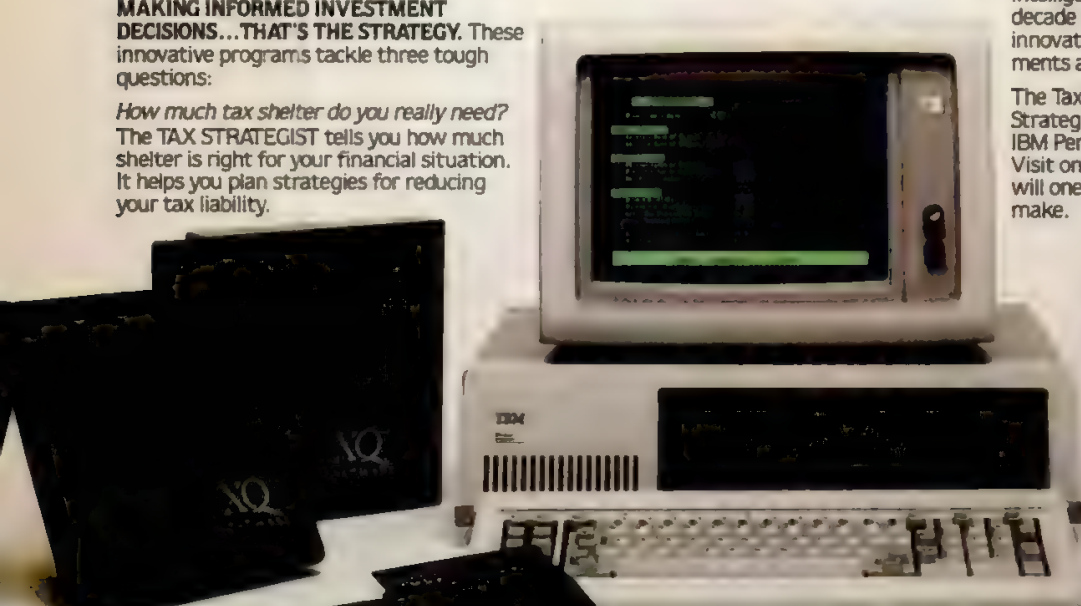
*How much tax shelter do you really need?*  
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Some of the games you see on these two pages help exercise your child's creativity. Others help improve vocabulary and spelling skills. While others

improve your child's writing and reading abilities. And all of them help your child understand how to use the computer.

So if you're looking for computer programs that do more than just "babysit" for your kids, read on. You'll find that our Early Learning Programs are not only compatible with Apple®, Atari®, IBM® and Commodore 64™ computers, but also with kids who like to have fun.



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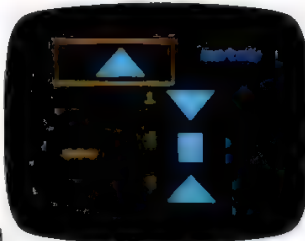
STORY MACHINE is like a storybook come to life. Using the keyboard, your children write their own fun little stories. The computer then takes what they've written and animates their story on the screen, com-



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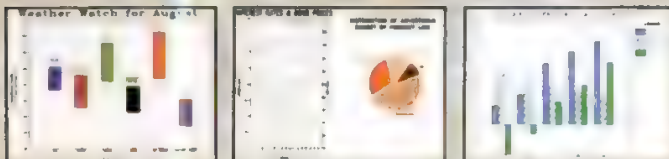
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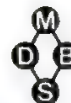
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May be used in conjunction with another MultiDisplay Card or IBM Video Card for simultaneous Display on Monochrome and Color Monitor

Until now, two expansion boards were required to have the options of using an IBM Monochrome and a composite video or RGB monitor. By putting these two functions plus a printer adaptor on one board, the USI MultiDisplay Card leaves one more slot open for future expansion and costs less.

Look for the USI MultiDisplay Card at your local computer dealer.

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A Division of USI International  
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Telephone: 415-468-4900

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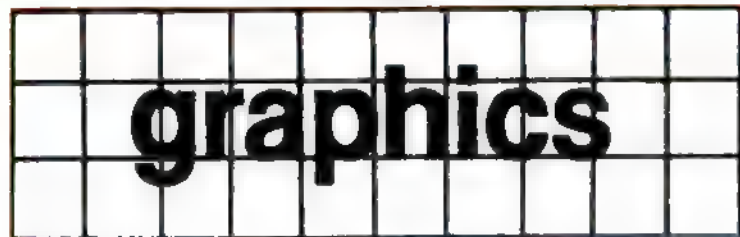
CIRCLE 478 ON READER SERVICE CARD



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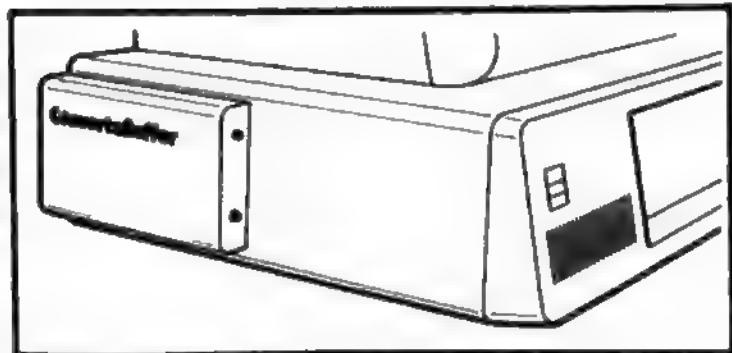


# ConvertaBuffer™

**IT'S A CONVERTER.** There was a time when buying a letter quality printer meant giving up graphics. Now, however, ConvertaBuffer™ gives you the best of both worlds by allowing you to print the business graphs generated by programs such as MBA and 1-2-3 on letter quality printers such as Diablo and NEC. And, the quality of these graphs are as good as those drawn by dot matrix printers such as the IBM/Epson. ConvertaBuffer translates the Epson-format graphics data output from MBA, 1-2-3, and other packages with graphics capability into the format necessary for printing on a letter quality printer.

**IT'S A BUFFER.** Generating graphics requires the outputting of a large amount of data to the printer. ConvertaBuffer speeds this process by receiving the data as fast as your PC can send it — 1,000 characters per second; storing up to 64K bytes of data in its built-in memory buffer; and then sending it to the printer at the printer's slower speed — 25 to 55 characters per second. This allows you to go on to other work without having to wait for the printer to finish printing.

**EASY TO INSTALL.** ConvertaBuffer comes with its own built-in cables which plug directly into your PC's printer adaptor and your printer's cable without removing the cover of the system unit — there is no need to buy an extra cable. And, each unit has its own fully regulated DC power supply — the unit does not steal power from the PC or the printer.



ConvertaBuffer also features a convenient front panel switch which resets the buffer to abort the printer output if desired. And, the status light indicates when ConvertaBuffer automatically switches to the graphics mode.

**HAVE YOUR CAKE AND EAT IT TOO!** The parallel-to-parallel ConvertaBuffer for graphics is the latest member of the ConvertaBuffer family. The original ConvertaBuffer enables you to connect any RS-232C serial interface equipped printer directly into the parallel printer port of your PC with up to 32K bytes of printer buffering.

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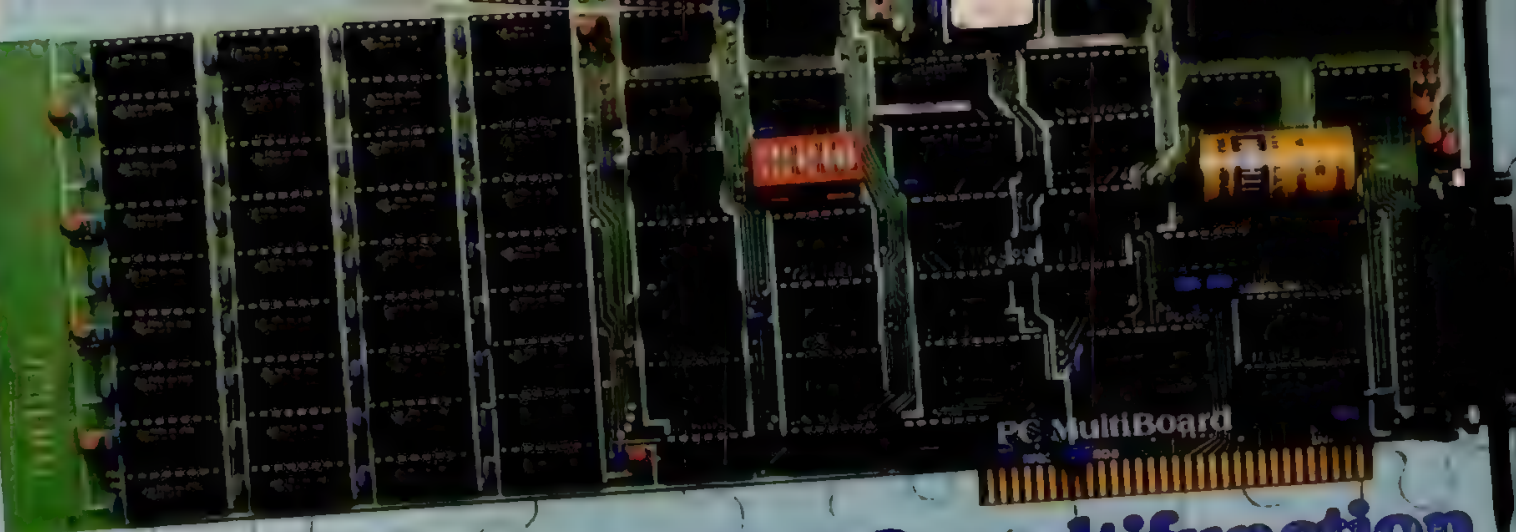
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Communications Electronics has teamed up with Wabash to provide a single-source solution for the diskette duplication requirements of software developers, OEM's and distributors. All service is in-house, to give you fast, dependable service. In most cases, delivery can be completed in five days. Whether you require 100, 1,000, or 10,000 copies per week, call CE first for a no obligation price quote. For additional information, please write us on your letterhead with your requirements.

SAVE ON WABASH DISKETTES Product Description	Part #	CE quant. 100 price per disk (\$)
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8" SSDD IBM Compatible (128 B/S, 26 Sectors)	F131	2.39
8" DSDD Soft Sector (Unformatted)	F14A	2.99
8" DSDD Soft Sector (256 B/S, 26 Sectors)	F144	2.99
8" DSDD Soft Sector (512 B/S, 15 Sectors)	F145	2.99
8" DSDD Soft Sector (1024 B/S, 8 Sectors)	F147	2.99
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5 1/4" Same as above, but bulk pack w/o envelope	M11AB	1.29
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5 1/4" SSQD Soft Sector w/Hub Ring (96 TPI)	M15A	2.59
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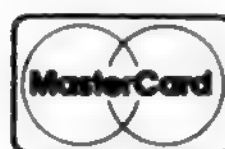
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# ANNOUNCING THE END OF WORD PROCESSOR CONFUSION

It's one confusing business, choosing a word processor. All those companies assuring you theirs is the most fantastic one of all. And leaving you to cut through all the smoke and hopefully whittle them down to the best one for you.

Well, we can help. If you'll just invest the next three minutes reading this, we'll tell you about a word processor that makes picking the right one a real breeze.

**FIRST, A WARNING.** There are two things you must do when evaluating any word processor. First, be careful. It's no secret that many of today's claims about being easy to learn and use just don't stand up to careful comparison. Watch carefully for complicated codes and programs that require "training sessions." Secondly, be selective. Buy a word processor you can use on a daily basis, not one that requires another "training session" when someone goes on vacation. In other words, be very careful to select

the word processor that's absolutely the best and easiest to use. Which is what we'll now introduce you to.

## **WHY ONE WORD PROCESSOR MAKES THE MOST SENSE OF**

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## **THE REMARKABLE**

**WORDPLUS-PC STORY.** In a nutshell, it's this. WordPlus-PC was designed from the ground up to be the very latest in word processing technology. It has all the important features you

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## **HOW WE CAN BE SO SURE OF OURSELVES.**

We're Professional Software, a leader in word processing software with over 30,000 customers contentedly churning out letters and documents around the world on personal and business computer systems. We know precisely what a top quality word processor must do. And we've studied all the shortcomings of our competitors. That's how WordPlus-PC came to be the easiest-to-use word processor ever.





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answers to questions. That's how WordPlus-PC helps you learn. In addition to the help you'll get from your dealer, we're ready to assist you when you call our special toll-free number and talk to one of our carefully trained advisors. This service is available at no charge during the 90 days following receipt of your user registration card. It's all part of Professional Software's total commitment to customer service and support.

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invoices or quotations. For large corporate customers, WordPlus-PC has the capability to merge information from files created by the firm's mini or mainframe computer. You can even type new documents while the system is printing other ones. And you'll find WordPlus fully compatible with virtually all popular ASCII letter-quality and dot matrix printers.

never any complicated or confusing codes to memorize or look up. Rather, the screen's "message area" reminds you how to do what you want. WordPlus-PC's unique keyboard color coding makes things even easier. And whenever there's a question, simply press the HELP function to get back on track.

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# Professional Software Inc.

51 Fremont Street, Needham, MA 02194 Telephone (617) 444-5224

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WordPlus-PC was designed and written by Andres Escallon.

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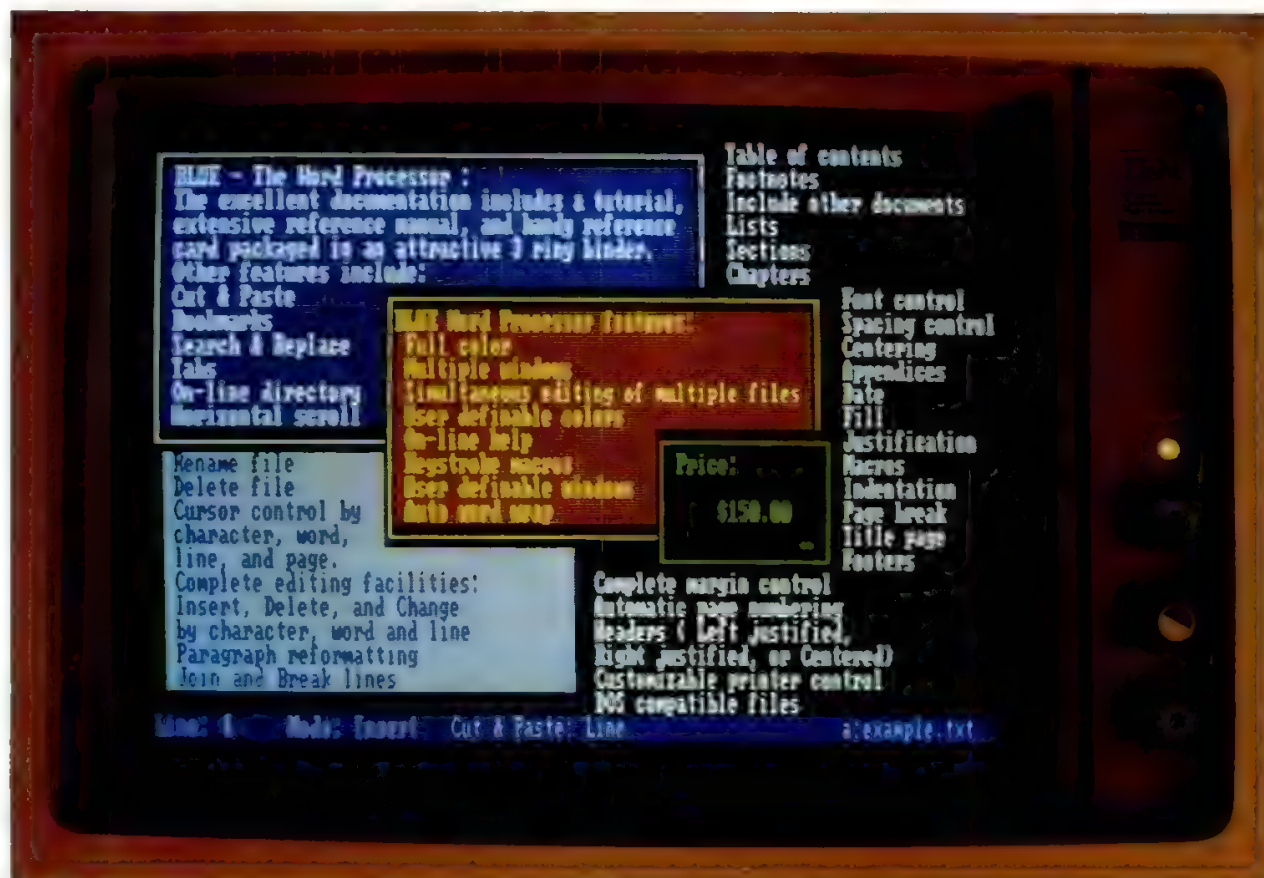
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Some expensive dedicated word processing systems offer automatic formatting features. Others offer simple manual screen formatting. Only Perfect Writer™ gives you both.

### Document Formatting

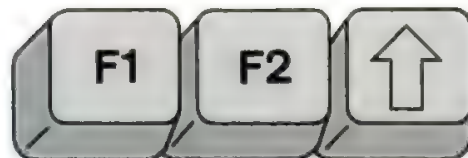
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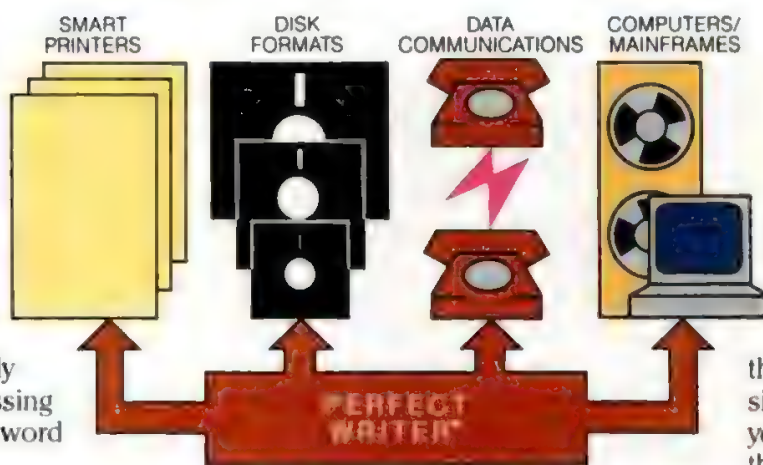
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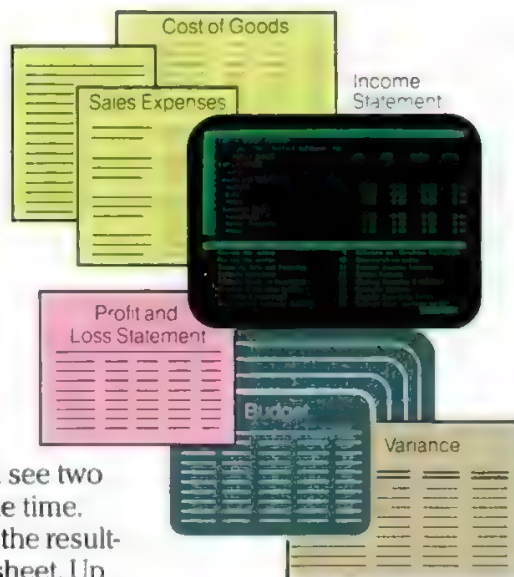
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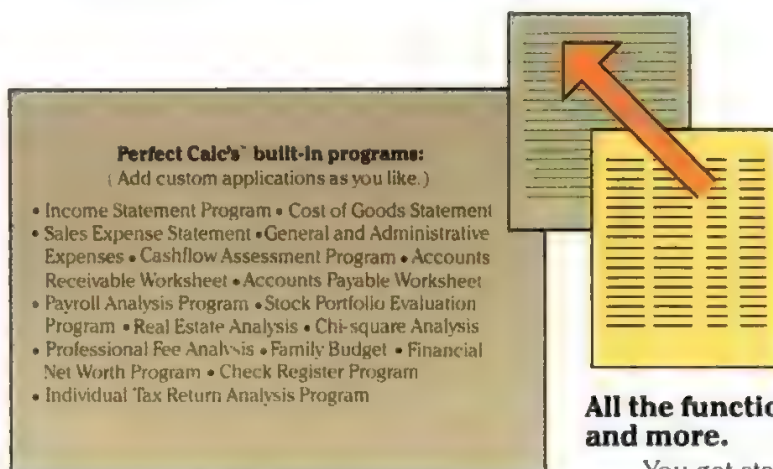
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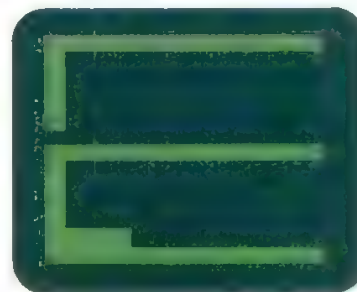
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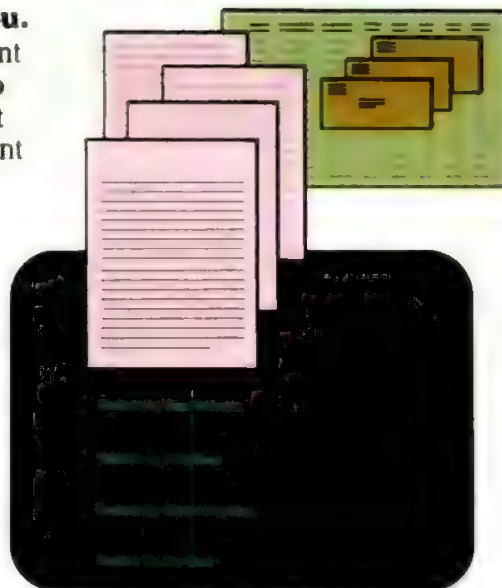
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INSTANT DATABASES AND REPORTS

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#### Information Management

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##### **AUTOMATIC:**

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##### Information management

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# Perfect Filer™

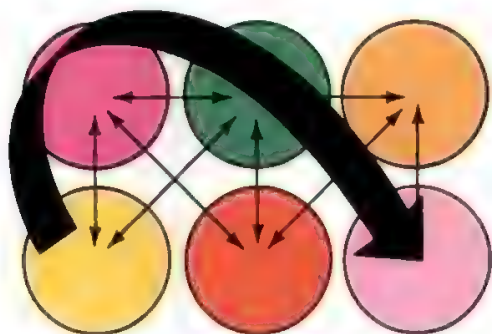
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FROM THE EDITOR'S SCREEN/COREY SANDLER

*The tale of a doomed racing handicapper, or, "Why I Never Made My Fortune as a Computer Programmer."*

# The \$2 Sure Thing

You could always tell a junior programmer when I was in college: He was the one walking around with a cardboard shoe box under his arm.

I remembered the shoe box the other day when I needed to transport a bit of coding for a printer selection program from my PC at home to my PC at work. I dumped a copy onto a floppy disk, tossed it into my coat jacket pocket, and dashed out the door to catch the 6:52 from Nanuet (also known as the Toonerville Trolley's poor stepcousin).

Anyway, the phones were already ringing by the time I got to the office and there were meetings to go to and authors to speak to and columns to write and the disk remained untouched in my pocket all day. When I got home that night, the disk was still there, an all-but-invisible passenger through the day.

This never would have happened back in the old days, I told myself, and then I remembered "The Case of the \$2 Sure Thing" and its battered shoe box. Actually, it wasn't a shoe box, it was a cardboard box full of IBM punch cards, a weight that could become quite oppressive as the cards began to mount up. You'd never forget you were carrying one.

My friend Ralph and I were two of the very few liberal arts students who dared enter the world of computers back then. It was mostly a matter of curiosity, for every-

one knew that writers and business people and other nontechnical people would never use a computer. That's why you hired a computer programmer and a computer operator and a systems analyst and a

team of consultants. There was something about computer people that was, well, different from you and me.

So there we were, squeezed in among the engineering and math types in "Intro-



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duction to Programming" in the temple of computing called "Machinery Hall." I am not going to attempt to demean the personal qualities of the rest of the class. (For one thing, they're all probably making much more money than I am today.) But let me just say that Ralph and I were the only ones present without a plastic pocket pen protector and in possession of glasses that were not held together at the bridge by a piece of electrical tape.

Down the hall from us, encased inside a glass-walled, air-conditioned and purified room with double-locked doors, sat the university's pride and joy, a massive IBM 360. Admission to the room was by special pass only, and we viewed with awe the high priests of the computer who were permitted to tiptoe around in its presence. In 6 years of study, I never touched an actual computer, only its outlying ganglia and peripherals.

Computers, I had been told, lived in a world of precision, where numbers, not words, ruled. It would be, the instructor claimed, a world in which everyone spoke a *lingua franca* of IFs, DOs, and GOTOs. Well, I quickly discovered that this simply wasn't true; if anything, computers were already entering into a land of Babel, with arcanelly titled languages like COBOL and APL and LISP. In fact, we weren't even to learn a mainstream language. Our first experience with programming was to be one computer model's dialect of a modification of a language: FORTRAN IV with WATFIV.

### Punch Card Approach

Our approach to the computer was made at punch card length. We first blocked out our programs using flow charts, then set about writing the coding on special forms marked off into 80 columns. That done, we approached the dreaded keypunch machines—a combination typewriter and thresher—that stood in rank upon rank in one part of the "user's area." If you think the IBM PC's keyboard at high speed sounds like a deranged woodpecker, you should have heard a skilled keypuncher at work. There was a constant fine spray of paper chaff flying out of the business end of the machines, and it clung like lint to the trousers of regular users. The cards flew out of the business end of the machine and into a hopper, from which you loaded your shoe box. You had to be careful, of course, to

remove any misspunched cards (or stapled, mutilated, or folded ones) and to watch out for other people's garbage.

Finally, the program done, we sidled up to a growling piece of machinery called a "card reader." Into the device's maw we fed our punched cards. It swallowed them up—sometimes eating a few in the process—and spit them out down below. And then we left for the day. Sure, computers were fast, but everyone knew there was a waiting line until the old IBM 360 would get to your program. Come back in a day, or maybe two if things were really busy.

**S**URE,  
*computers were fast, but  
everyone knew there  
was a waiting line until  
the old IBM 360 would  
get to your program.*

And then we came back—back to find that our elegant 20-line FORTRAN IV with WATFIV program to calculate college Grade Point Average (a common "serious" application in our class) had stopped at Line 2 because we had used a period instead of a comma in a READ statement. Fix the card, feed the whole pack back into the card reader, and come back in another 24 hours to see if the program had progressed to Line 3.

There was a worse fate than finding a one-page printout with an early error code, and that was finding a 3-inch thick wad of printout with your name on it in a special rack down at the end of the shelf. The rack was marked "Endless Loops," and anyone venturing to its corner had to face the scornful stare of the clerks whose job it was to monitor the printer and console, and catch programs sent into limbo by rookie programmers. Guilty, your honor. Regularly.

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claiming race somewhere and paid \$442.87 on a \$2 win ticket. That seemed like an awful lot of money to us, impoverished college students that we were. Knowing absolutely nothing about horses and racing, a few of us stumbled across a copy of *The Racing Form* in the trash outside an English professor's office.

In case you've never seen *The Racing Form*, this daily newspaper is just packed with numbers and ratings and timings. You can find out where a horse has been racing, from what post position it started, where it was at the first quarter, at the half-way point, at the top of the stretch, and at the finish line. You can learn about the weight carried (jockey plus compensating lead packets); about the purses won; about a horse's parentage. It is a daily update to a massive database.

Our final assignment for Introduction to Programming was to write a Serious Program. The rest of the class worked on exciting things like The Sieve of Eratosthenes, calculating pi to 10,000 places and figuring out the fifteenth Perfect Number. Ralph and I set out to write a horse-racing handicapping program for Vernon Downs.

The program was, in retrospect, a very simple one, although it hardly seemed so at the time. Every horse had a card of its own. We put on it its total winnings, its number of wins, places, and shows, its "Speed Rating" (about which we understood nothing, but the number sounded very significant), and a few other factors. We asked the program to divide the number of starts by the number of wins, calculate the average payoff, factor in the Speed Rating somehow, and then print out the value of X. The highest rating would be the IBM 360's prediction of the winner.

The first eight times we tried to run our thick pack of punchcards we got no further than the twelfth card. We tried double-teaming, each debugging a different part of the program, and that pushed us to the fortieth line. And then finally, just 5 days before our term project was due, the printout we received included a full run of the program, without errors, and with a nice, confident prediction based on that afternoon's racing program: Number 5, on the nose, in the sixth. Well, we could hardly wait until the Sports Final edition of the newspaper made its way to the neighborhood candy store. There, in plain black type, was red-letter news: The win-

ner of the sixth race was Number 5, paying \$17.80 for a \$2 bet. We were cautiously giddy.

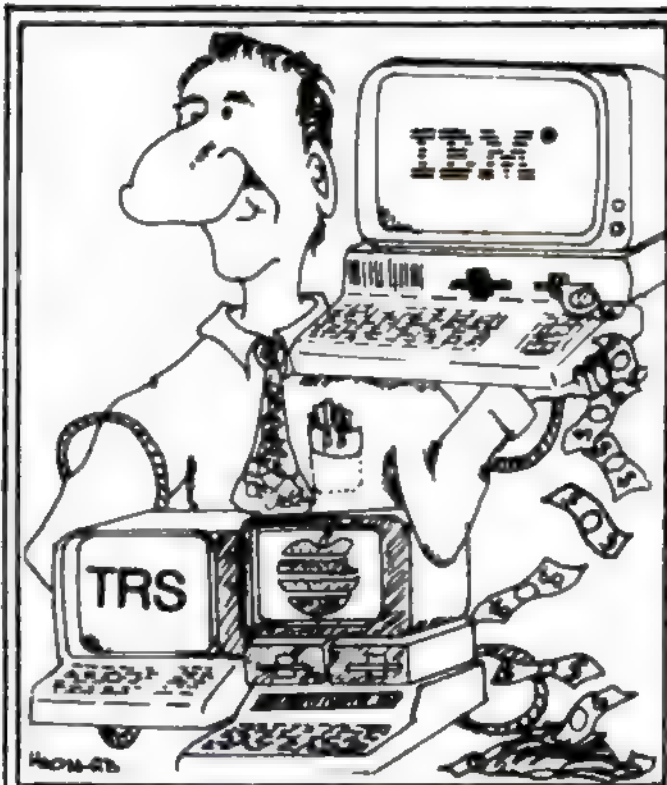
We ran back to Machinery Hall and knocked out another set of punch cards for the next day's fourth race and then fed it into the card reader. Twelve hours later we stood anxiously at the printout bins. A nice, one-page printout awaited us: Number 5 to win, it advised. And yes, Number 5 won. We were now seriously giddy.

It was not yet time to head for our neighborhood bookie. To begin with, it was Thursday already, and our project was due in the professor's office the next day. There was one more test—a big stakes race down at Belmont. We scoured *The Racing Form* and put in every variable we could find. We ran the cards through the reader and retreated to our apartments to stew, visions of fists full of winning tickets dancing in our brains.

Well, we picked up the printout right around post time, and dashed over to the campus radio station and stood around the AP sports ticker. We were a little bit skeptical, because once again the computer had selected Number 5. Well, the probability factor seemed so remote, but somehow as the horses came around the final turn and into the top of the stretch, Number 5 broke from the back of the field and charged past the grandstand to win an upset victory. We were well past giddy now, but we somehow managed to pull together a printout of our program and a short, modest summary of our achievements and deliver it to the professor. Saturday we were going to the track.

**W**  
**E**  
*retreated to our  
apartments to stew,  
visions of fists full of  
winning tickets dancing  
in our brains.*

At 11 p.m. that night, the phone rang. It was a most solemn Ralph: "I have a little problem," he began. "I dropped the shoe box and the cards got all jumbled." I laughed. "That's no problem. Just use the



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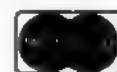
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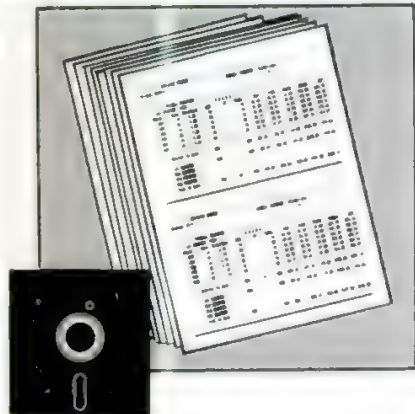
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CIRCLE 534 ON READER SERVICE CARD

PC MAGAZINE 46 SEPTEMBER

printout of the program to put them back in order," I said.

"I did that," Ralph said ominously. "Do you want to guess what I found?" There was a long pause, and Ralph pushed on unasked: "I found an extra card, just before the print statement. It wasn't one of ours. It said, 'X = 5'."

**THE**  
*computer boldly  
declared the Number 1  
horse a \$2 Sure Thing.*

It took just a few moments for the import of Ralph's statement to sink in. After all of our computations, and after each horse had been assigned a rating, this infiltrating card was resetting the final X variable to 5, the same number we had seen as our program's picks for all three races.

We met down at Machinery Hall at midnight. Ralph clutched the shoe box to his breast, the offending extra card waving accusingly in his left hand. As chance would have it, the computing center was very quiet that night and we somehow managed to hit a sweet spot in time when our program could be read into the computer and the printout returned to the rack in 20 minutes or so.

We resubmitted the cards for the stakes race at Belmont. The computer picked the Number 8 horse, a filly that barely managed to complete the mile-and-an-eighth. We put in the cards for the Sixth at Vernon: Number 3, the program said. Number 3 had balked coming out of the gate and then had struggled gamely to come in eighth. We tried the fourth from Vernon: The computer boldly declared the Number 1 horse a \$2 Sure Thing. According to the newspaper, that horse had tied for sixth, and then only because two horses in front of him had been disqualified.

We struggled on wearily through most of the night, never again picking a winner. Things had been so much simpler when our program had reported false results. And that is the story of why I never made my fortune as a racing handicapper... or as a computer programmer. **/PC**



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CIRCLE 219 ON READER SERVICE CARD





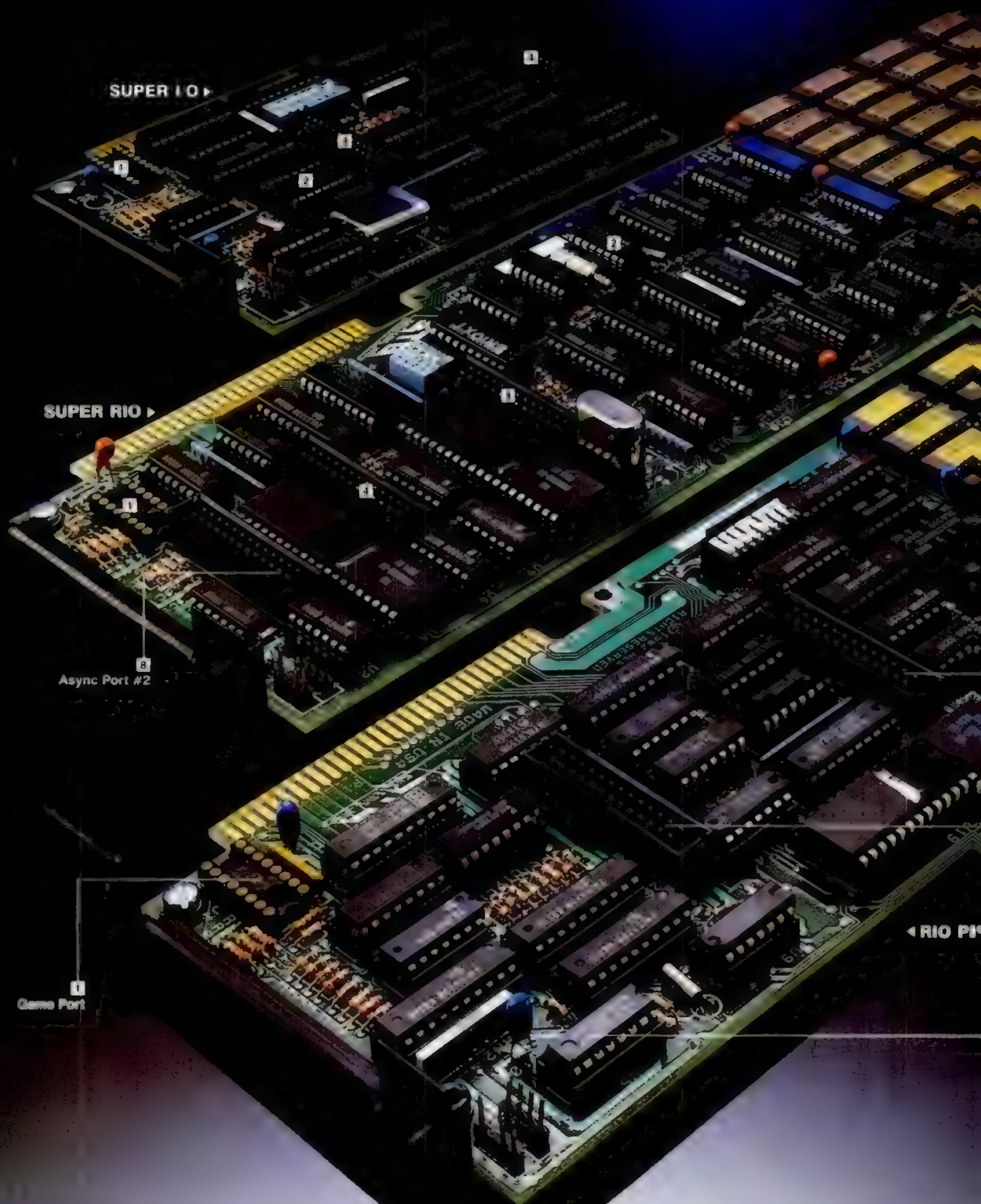
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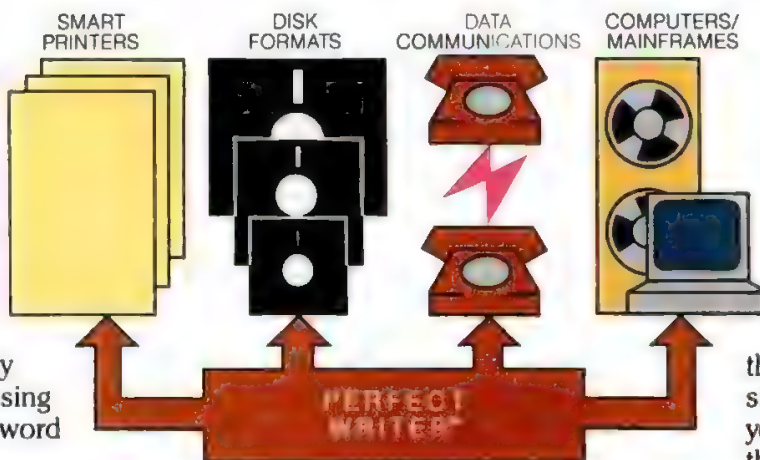
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# Perfect

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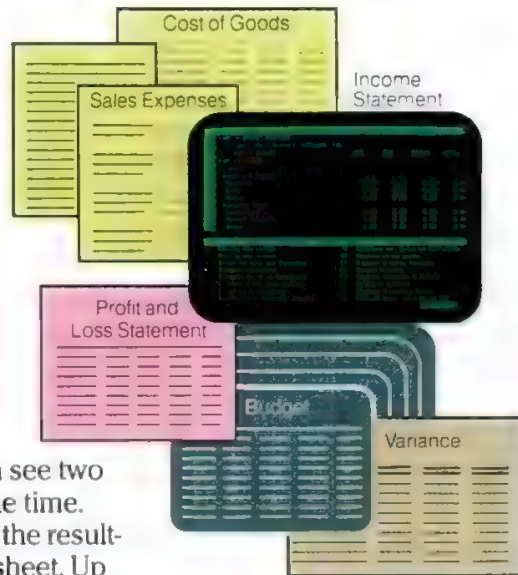
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### How Perfect Calc's™ multiple file association really pays off.

A good example is the built-in Income Statement Program. The income spreadsheet automatically reads from three other spreadsheets: Cost of Goods Statement, General and Administrative Expenses Statement, and Sales Expenses. All four are on-line simultaneously. All you do is fill in the blanks.

Then use all that information to perform an instant analysis and illustrate the results of potential budget cuts or increases. You change just one spreadsheet using the fill-in-the-blanks style. Perfect

Calc™ automatically takes care of the rest.

### Setting up the Perfect™ spreadsheet!

Entering titles, labels, and additional information on your spreadsheet is easy with Perfect Calc™. It recognizes words automatically and handles them correctly without any special commands. If you want to use numbers—like dates—for item labels, that's easy, too.

Individually variable column widths add flexibility in setting up your Perfect Calc™ spreadsheet. And once you've developed one spreadsheet, you can use it as a template for other applications. Simply refer to it.

### Self-teaching software.

Easy, software-based lessons are included to make learning spreadsheet techniques simple. The lessons are matched to guides in the user manuals so

#### Multiple Spreadsheets

##### Associated Spreadsheets **AUTOMATIC:**

No double work—use any information you choose simply by referring to other spreadsheets. Move information, formulas or whole spreadsheets freely between multiple spreadsheets. Permits fill-in-the-blanks automatic forecasting and planning. 16 built-in application programs are included.

##### Spreadsheet Consolidation **MANUAL:**

Simple cut-and-paste spreadsheet entries. Line, column, or whole spreadsheet additions from any one of seven on-line spreadsheets are also easy with Perfect Calc™.

**Only Perfect Calc™ does both.**



# Perfect Calc™

## split-screen spreadsheets window display.

Sixteen applications built in. And that's only the beginning.

you can follow along in the text. Because you learn on the computer at your own pace, there's no pressure to perform. Try new applications when you are ready.

### The most complete applications.

Perfect Calc™ is the only spreadsheet you can buy with 16 applications built in. Standard paper and pencil financial tools are ready to use. All you do is fill in the blanks.

Just a simple command is all you need to start working. And on-screen tutorials and English prompts give you assistance whenever you need it.

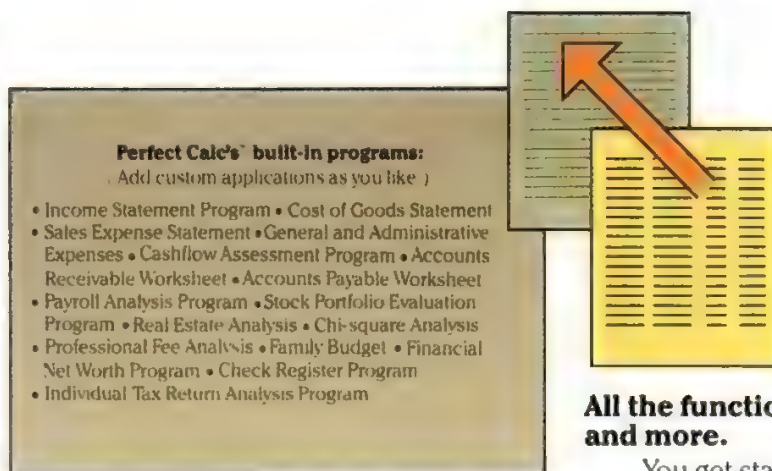
### Handy cursor commands.

You can move the cursor easily to the top of a column, beginning or end of a line, to the page before or after—with a single command.

And you can go back and forth between two spreadsheets on split-screen display with just as much ease. That makes multiple spreadsheet handling easier than ever before.

### The most compatible spreadsheets.

Perfect Calc™ data is stored in true ASCII files—the files read and recognized by every computer system. So, it's simple to use a Perfect Calc™ spreadsheet in a Perfect Writer™ report or letter. Or, build graphic displays using the information in one of your spreadsheets.



#### Perfect Calc's™ built-in programs:

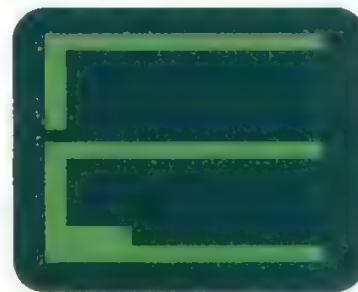
(Add custom applications as you like )

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- Sales Expense Statement • General and Administrative Expenses • Cashflow Assessment Program • Accounts Receivable Worksheet • Accounts Payable Worksheet
- Payroll Analysis Program • Stock Portfolio Evaluation Program • Real Estate Analysis • Chi-square Analysis
- Professional Fee Analysis • Family Budget • Financial Net Worth Program • Check Register Program
- Individual Tax Return Analysis Program

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You get standard functions for financial, scientific, and engineering applications plus an expandable functions library which allows you to add new formulas as you like. You can write your own complex applications programs by writing it on a Perfect Calc™ spreadsheet and

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# Pertec

## Success in manag

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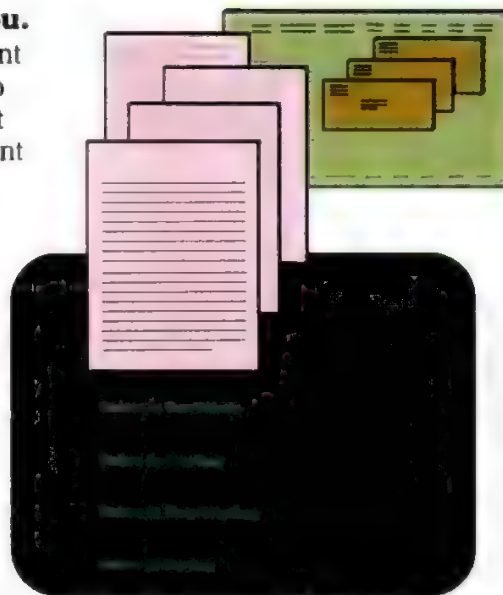
### Put information to work for you.

Most information management systems are either too small or too difficult to use. Now there's Perfect Filer™. It's an executive management information system that's easy to use. You can keep track of mailing lists, clients, sales, merchandise, names and addresses, and much more.

### Easy to get started.

Two ready-to-use data entry forms are provided so that you can begin using Perfect Filer™ immediately. One is for individuals, the other for companies and organizations. You only type important information once. Perfect Filer™ does the rest for you. No special training is required, and your entire staff can use it.

On-line references and English prompts provide



INSTANT DATABASES AND REPORTS

assistance when you have questions. Tutorials are included for improving your skills with Perfect Filer™.

### Personalized form letters.

Use Perfect Filer™ together with Perfect Writer's™ powerful word processing features to add a personal touch to mass mailing letters. You can even tag different groups within one mailing list so that their letters include special paragraphs, subsections or operator-typed comments.

And Perfect Filer™ remembers nicknames, titles—even your special salutation for clients or friends.

Generate mailing lists.

Form letters. Specialized record-keeping forms and sorted lists. You can choose from the two data entry forms provided or from seven data entry groups.



### Creating custom data bases has never been this automatic.

Single-keystroke data entry menus do the work for you. You enter your data just once on a blank Perfect Filer™ data entry form—whether it be client addresses, direct mail sorting codes, payment records, inventory, or standing orders.

Perfect Filer™ makes successful information management simple.

#### Information Management

##### Data entry forms

##### **AUTOMATIC:**

Use Perfect Filer's™ built-in data entry forms to create your own records file. All of the parameters have been pre-defined. Just enter information on the convenient entry form.

##### Information management

##### **MANUAL:**

Create custom data bases with ease. You can build an entirely new structure or use data entry groups from existing formats to construct a customized data base with exactly the information you want to manage.

**Only Perfect Filer™ offers you both.**



# - Filer™

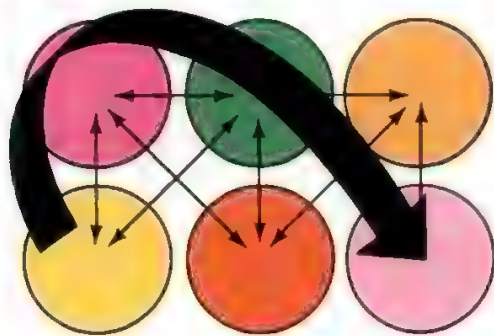
## formation ment.

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Our advanced programming design offers you the highest level of software compatibility and "intelligent" automatic features. It's Perfect Software™ for today's problems. And tomorrow's solutions.

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*The tale of a doomed racing handicapper, or, "Why I Never Made My Fortune as a Computer Programmer."*

# The \$2 Sure Thing

You could always tell a junior programmer when I was in college: He was the one walking around with a cardboard shoe box under his arm.

I remembered the shoe box the other day when I needed to transport a bit of coding for a printer selection program from my PC at home to my PC at work. I dumped a copy onto a floppy disk, tossed it into my coat jacket pocket, and dashed out the door to catch the 6:52 from Nanuet (also known as the Toonerville Trolley's poor stepcousin).

Anyway, the phones were already ringing by the time I got to the office and there were meetings to go to and authors to speak to and columns to write and the disk remained untouched in my pocket all day. When I got home that night, the disk was still there, an all-but-invisible passenger through the day.

This never would have happened back in the old days, I told myself, and then I remembered "The Case of the \$2 Sure Thing" and its battered shoe box. Actually, it wasn't a shoe box, it was a cardboard box full of IBM punch cards, a weight that could become quite oppressive as the cards began to mount up. You'd never forget you were carrying one.

My friend Ralph and I were two of the very few liberal arts students who dared enter the world of computers back then. It was mostly a matter of curiosity, for every-

one knew that writers and business people and other nontechnical people would never use a computer. That's why you hired a computer programmer and a computer operator and a systems analyst and a

team of consultants. There was something about computer people that was, well, different from you and me.

So there we were, squeezed in among the engineering and math types in "Intro-



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**CIRCLE 161 ON READER SERVICE CARD**



duction to Programming" in the temple of computing called "Machinery Hall." I am not going to attempt to demean the personal qualities of the rest of the class. (For one thing, they're all probably making much more money than I am today.) But let me just say that Ralph and I were the only ones present without a plastic pocket pen protector and in possession of glasses that were not held together at the bridge by a piece of electrical tape.

Down the hall from us, encased inside a glass-walled, air-conditioned and purified room with double-locked doors, sat the university's pride and joy, a massive IBM 360. Admission to the room was by special pass only, and we viewed with awe the high priests of the computer who were permitted to tiptoe around in its presence. In 6 years of study, I never touched an actual computer, only its outlying ganglia and peripherals.

Computers, I had been told, lived in a world of precision, where numbers, not words, ruled. It would be, the instructor claimed, a world in which everyone spoke a lingua franca of IFs, DOs, and GOTOs. Well, I quickly discovered that this simply wasn't true; if anything, computers were already entering into a land of Babel, with arcanelly titled languages like COBOL and APL and LISP. In fact, we weren't even to learn a mainstream language. Our first experience with programming was to be one computer model's dialect of a modification of a language: FORTRAN IV with WATFIV.

### Punch Card Approach

Our approach to the computer was made at punch card length. We first blocked out our programs using flow charts, then set about writing the coding on special forms marked off into 80 columns. That done, we approached the dreaded keypunch machines—a combination typewriter and thresher—that stood in rank upon rank in one part of the "user's area." If you think the IBM PC's keyboard at high speed sounds like a deranged woodpecker, you should have heard a skilled keypuncher at work. There was a constant fine spray of paper chaff flying out of the business end of the machines, and it clung like lint to the trousers of regular users. The cards flew out of the business end of the machine and into a hopper, from which you loaded your shoe box. You had to be careful, of course, to

remove any misspunched cards (or stapled, mutilated, or folded ones) and to watch out for other people's garbage.

Finally, the program done, we sidled up to a growling piece of machinery called a "card reader." Into the device's maw we fed our punched cards. It swallowed them up—sometimes eating a few in the process—and spit them out down below. And then we left for the day. Sure, computers were fast, but everyone knew there was a waiting line until the old IBM 360 would get to your program. Come back in a day, or maybe two if things were really busy.

**SURE,**  
*computers were fast, but  
everyone knew there  
was a waiting line until  
the old IBM 360 would  
get to your program.*

And then we came back—back to find that our elegant 20-line FORTRAN IV with WATFIV program to calculate college Grade Point Average (a common "serious" application in our class) had stopped at Line 2 because we had used a period instead of a comma in a READ statement. Fix the card, feed the whole pack back into the card reader, and come back in another 24 hours to see if the program had progressed to Line 3.

There was a worse fate than finding a one-page printout with an early error code, and that was finding a 3-inch thick wad of printout with your name on it in a special rack down at the end of the shelf. The rack was marked "Endless Loops," and anyone venturing to its corner had to face the scornful stare of the clerks whose job it was to monitor the printer and console, and catch programs sent into limbo by rookie programmers. Guilty, your honor. Regularly.

### A \$2 Win

Well, it happened in September, some 15 years or so ago, that a horse—his name has blissfully departed from memory—came from out of nowhere in a cheap

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claiming race somewhere and paid \$442.87 on a \$2 win ticket. That seemed like an awful lot of money to us, impoverished college students that we were. Knowing absolutely nothing about horses and racing, a few of us stumbled across a copy of *The Racing Form* in the trash outside an English professor's office.

In case you've never seen *The Racing Form*, this daily newspaper is just packed with numbers and ratings and timings. You can find out where a horse has been racing, from what post position it started, where it was at the first quarter, at the half-way point, at the top of the stretch, and at the finish line. You can learn about the weight carried (jockey plus compensating lead packets); about the purses won; about a horse's parentage. It is a daily update to a massive database.

Our final assignment for Introduction to Programming was to write a Serious Program. The rest of the class worked on exciting things like The Sieve of Eratosthenes, calculating pi to 10,000 places and figuring out the fifteenth Perfect Number. Ralph and I set out to write a horse-racing handicapping program for Vernon Downs.

The program was, in retrospect, a very simple one, although it hardly seemed so at the time. Every horse had a card of its own. We put on it its total winnings, its number of wins, places, and shows, its "Speed Rating" (about which we understood nothing, but the number sounded very significant), and a few other factors. We asked the program to divide the number of starts by the number of wins, calculate the average payoff, factor in the Speed Rating somehow, and then print out the value of X. The highest rating would be the IBM 360's prediction of the winner.

The first eight times we tried to run our thick pack of punchcards we got no further than the twelfth card. We tried double-teaming, each debugging a different part of the program, and that pushed us to the fortieth line. And then finally, just 5 days before our term project was due, the printout we received included a full run of the program, without errors, and with a nice, confident prediction based on that afternoon's racing program: Number 5, on the nose, in the sixth. Well, we could hardly wait until the Sports Final edition of the newspaper made its way to the neighborhood candy store. There, in plain black type, was red-letter news: The win-

ner of the sixth race was Number 5, paying \$17.80 for a \$2 bet. We were cautiously giddy.

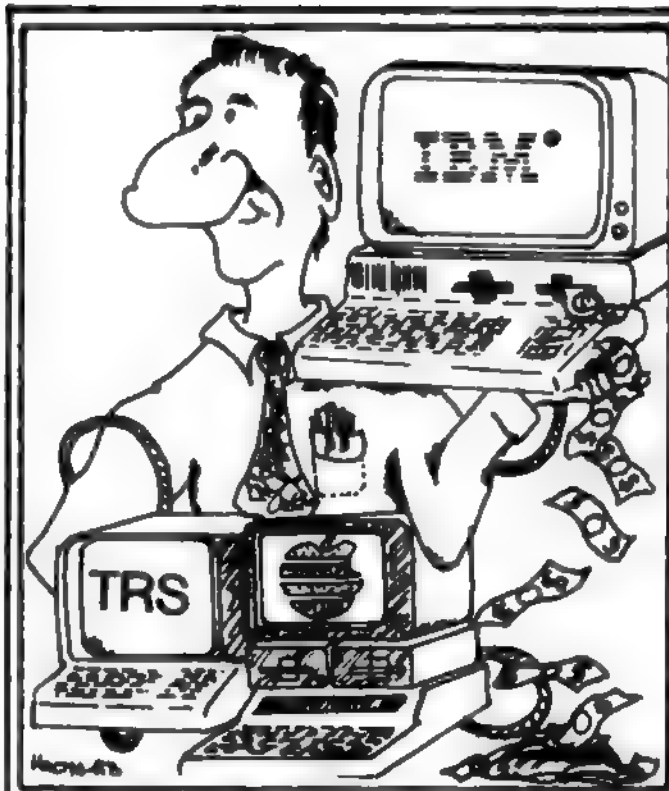
We ran back to Machinery Hall and knocked out another set of punch cards for the next day's fourth race and then fed it into the card reader. Twelve hours later we stood anxiously at the printout bins. A nice, one-page printout awaited us: Number 5 to win, it advised. And yes, Number 5 won. We were now seriously giddy.

It was not yet time to head for our neighborhood bookie. To begin with, it was Thursday already, and our project was due in the professor's office the next day. There was one more test—a big stakes race down at Belmont. We scoured *The Racing Form* and put in every variable we could find. We ran the cards through the reader and retreated to our apartments to stew, visions of fists full of winning tickets dancing in our brains.

Well, we picked up the printout right around post time, and dashed over to the campus radio station and stood around the AP sports ticker. We were a little bit skeptical, because once again the computer had selected Number 5. Well, the probability factor seemed so remote, but somehow as the horses came around the final turn and into the top of the stretch, Number 5 broke from the back of the field and charged past the grandstand to win an upset victory. We were well past giddy now, but we somehow managed to pull together a printout of our program and a short, modest summary of our achievements and deliver it to the professor. Saturday we were going to the track.

**W**<sub>E</sub>  
*retreated to our  
apartments to stew,  
visions of fists full of  
winning tickets dancing  
in our brains.*

At 11 p.m. that night, the phone rang. It was a most solemn Ralph: "I have a little problem," he began. "I dropped the shoe box and the cards got all jumbled." I laughed. "That's no problem. Just use the



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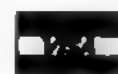
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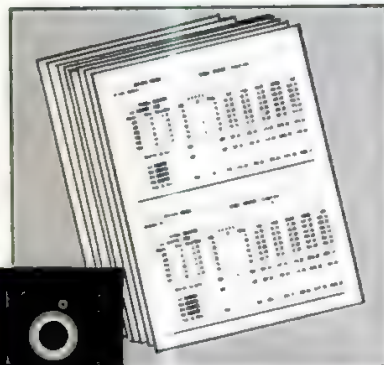
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PC MAGAZINE 46 SEPTEMBER

printout of the program to put them back in order," I said.

"I did that," Ralph said ominously. "Do you want to guess what I found?" There was a long pause, and Ralph pushed on unasked: "I found an extra card, just before the print statement. It wasn't one of ours. It said, 'X = 5'."

**THE**  
*computer boldly  
 declared the Number 1  
 horse a \$2 Sure Thing.*

It took just a few moments for the import of Ralph's statement to sink in. After all of our computations, and after each horse had been assigned a rating, this infiltrating card was resetting the final X variable to 5, the same number we had seen as our program's picks for all three races.

We met down at Machinery Hall at midnight. Ralph clutched the shoe box to his breast, the offending extra card waving accusingly in his left hand. As chance would have it, the computing center was very quiet that night and we somehow managed to hit a sweet spot in time when our program could be read into the computer and the printout returned to the rack in 20 minutes or so.

We resubmitted the cards for the stakes race at Belmont. The computer picked the Number 8 horse, a filly that barely managed to complete the mile-and-an-eighth. We put in the cards for the Sixth at Vernon: Number 3, the program said. Number 3 had balked coming out of the gate and then had struggled gamely to come in eighth. We tried the fourth from Vernon: The computer boldly declared the Number 1 horse a \$2 Sure Thing. According to the newspaper, that horse had tied for sixth, and then only because two horses in front of him had been disqualified.

We struggled on wearily through most of the night, never again picking a winner. Things had been so much simpler when our program had reported false results. And that is the story of why I never made my fortune as a racing handicapper... or as a computer programmer. /PC



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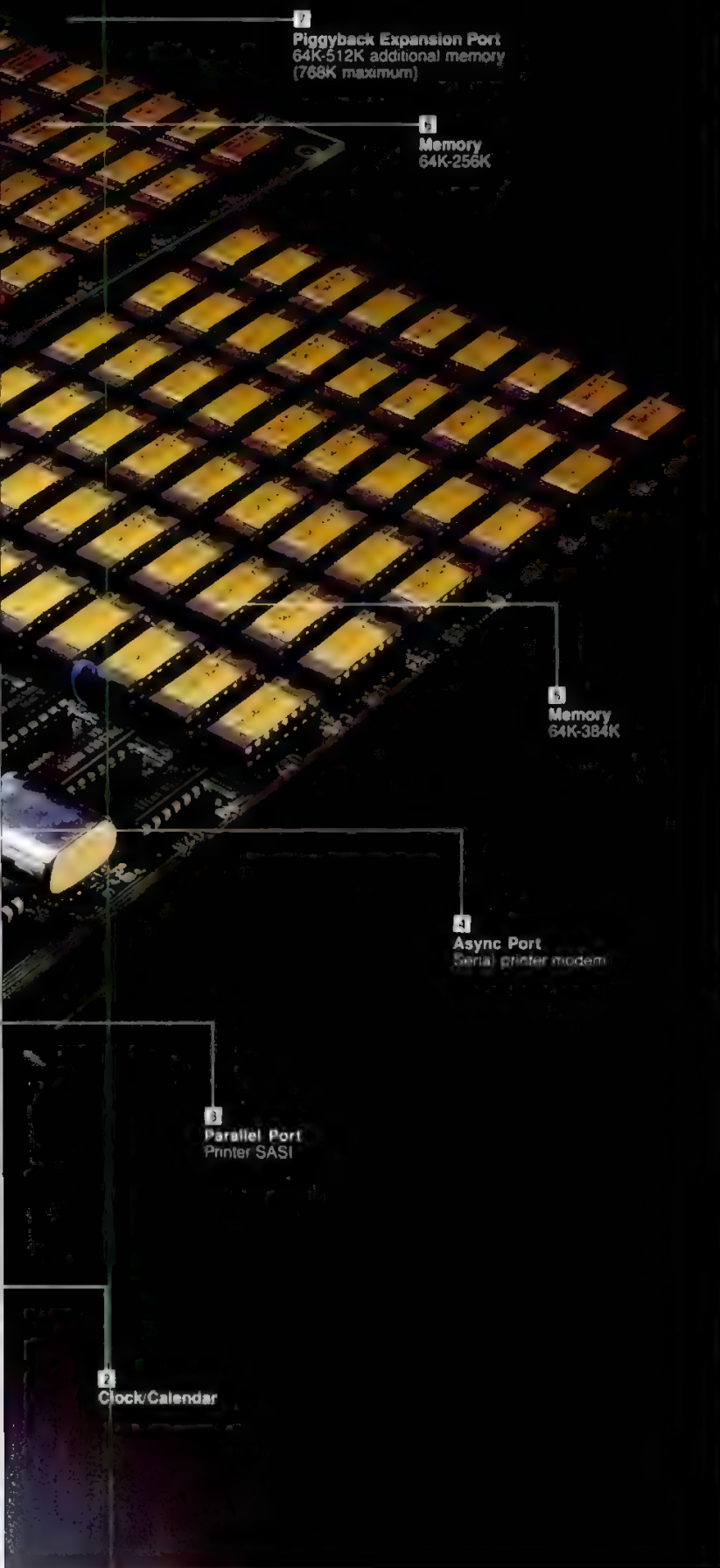
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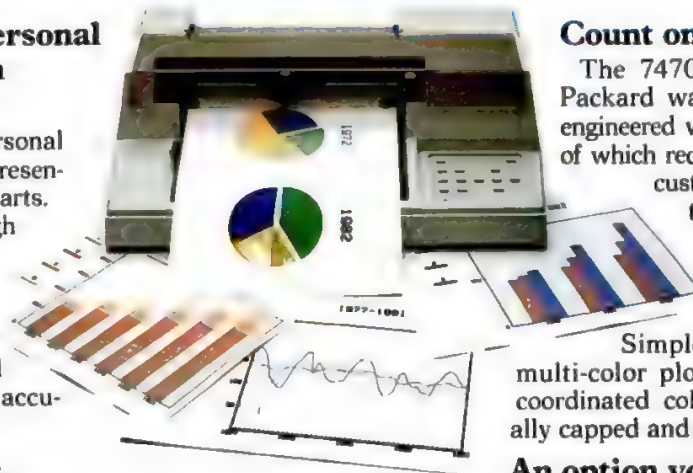
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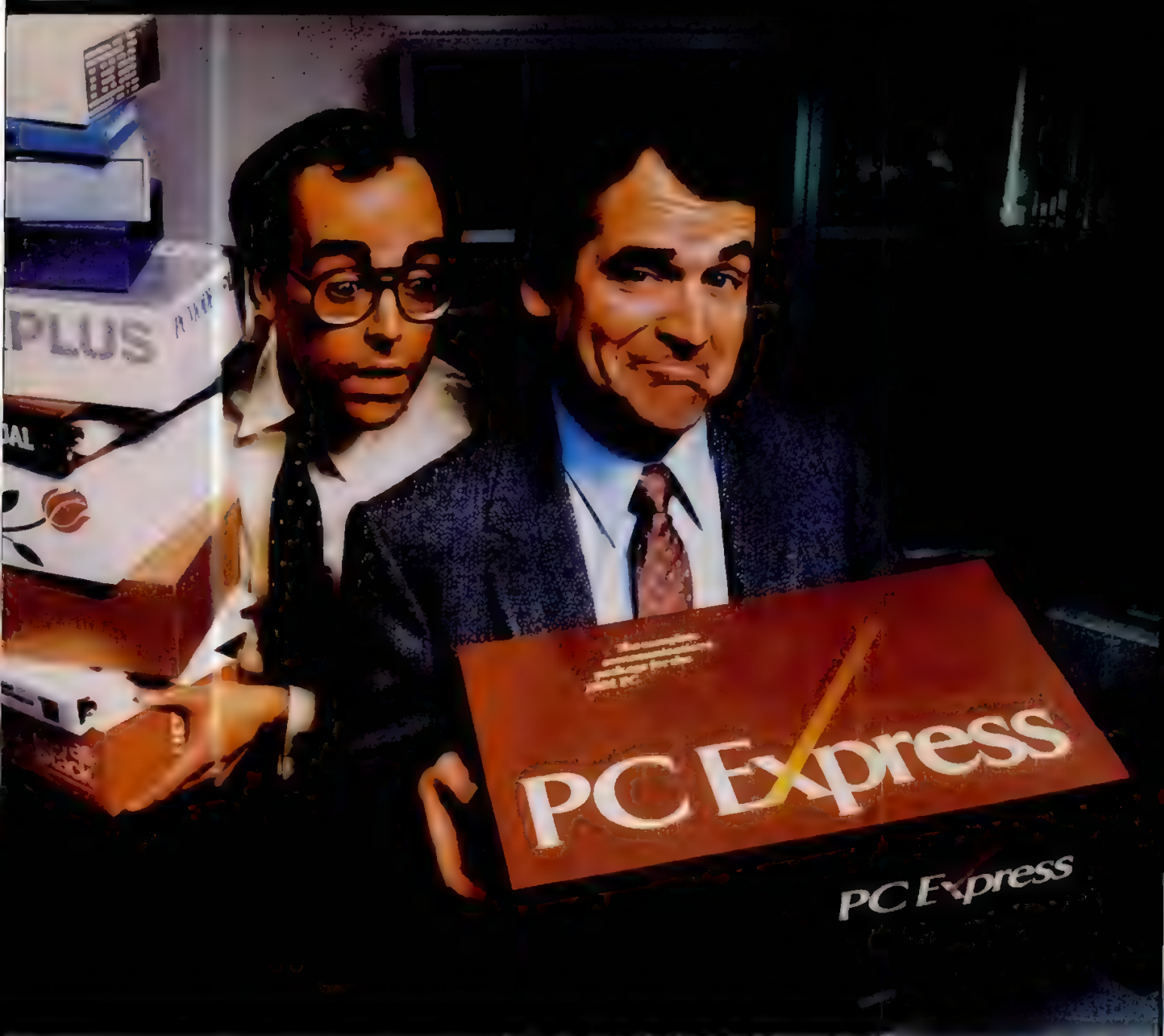
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# Letters To PC

## Hooray!

Many thanks to PC for calling the attention of its readers to the use of computers by the handicapped ("Helping The Handicapped Through Computers" and Dal Vordahl's letter in "PC Tutor," PC, Volume 2 Number 1).

My son Mark, a high-level quadriplegic, bought an IBM PC in December. The quality of his reports and homework increased greatly. So did his grades. The PC is going to be a real boon when he goes to college this fall.

But, like Vordahl, Mark can only strike one key at a time. We solved the multiple keystroke problem somewhat satisfactorily by buying two teardrop-shaped fishing weights, cutting off the small wire loop, filing the bottom flatter, and inserting a wire through the hole in the weights.

We then pounded the wire into the bottom of the weight and covered the bottom with a nonskid, rubberized fabric to prevent slipping and marring of the keys. We bent the upper part of the wire into an open loop so that Mark could pick it up with his "mouth stick" (a device much like an athlete's mouth guard with a stick extending from it.) Mark is now able to pick up and place the weight on one key, then depress the other with his mouth stick. It's a nuisance, but it works.

The future use of computers and other electronic equipment in helping the handicapped in communications, employment, and independence is exciting. While I realize that some obstacles to use by the handicapped of some products may be difficult to overcome, I wish the manufacturers would consider submitting some of their products to a panel of handicapped people for suggestions. Changing a connection here and there may make a product easier for all to use.

It's a matter of thoughtful planning and design.

But does anyone have a solution to those godawful thick, three-ring manuals? They are impossible to flip through with a mouthstick without tearing the pages.



Thanks again, and please keep working to make personal computers barrier-free.

Ronald P. McKenzie  
Green Bay, Wisconsin

Thanks for your letter. For another idea for handicapped PC-users, see "Multi-Key Solution for Handicapped" in this month's "User-To-User" column.

## Mail on Mail Order

I wish to commend PC Magazine! It's about time a publication of your professional status gave recognition to the significant and beneficial role that mail order and discount firms play in the microcomputer software market.

I would also like to thank Corey Sandler for his article "Down By The Old Mill Stream" (PC, Volume 2 Number 2). As an IBM PC software mail order firm, we appreciate his bringing out into the open the truths behind those mail order firms that are honorable.

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Garden City, New York

I have been involved in the development and marketing of software for more than 10 years without ever making a mail order purchase. I'm skeptical by nature and definitely prefer to see the product before buying.

Recently, after reading "The Simplicity of QWERTY" by Tom McLaren (PC, Volume 1 Number 12), I decided to experiment. My wife is a budding novelist and needs a good word processor designed for regular people (she's an author, not a programmer). QWERTY sounded good in the article, but it was the \$20 trial that caught my attention.

This one seemed too good to be true, and I was willing to spend 20 bucks to see where the catch was. I called HFK Software, expecting to be told that I would have to pay the full price and then fight for a refund at a later date. To my surprise, I was told that \$20 was all it would cost to try a full-function QWERTY for a month.

When I asked how long it would take to get a copy of QWERTY to try, I was





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# Letters To PC

told that the program would be shipped the next day if I gave a Master Charge number over the phone. Our trial copy must have been shipped that day, because it arrived almost instantly.

The product is excellent and a joy to use, and as McLaren says in the article, "The manual is a model of appropriate documentation." We've been using QWERTY for 2 weeks now and I've found the catch. We were "baited" into trying it for \$20 and now that we're hooked, we'll have to buy it!

Dennis R. Galotti  
Maynard, Massachusetts

## Redefinition Redefined

Kenneth Wood's article, "Defining Function Keys With PC-DOS 2.0" (PC, Volume 2 Number 1), was a big disappointment. I want very much to change the meaning of a key and I can't understand the instructions in the DOS manual, but Wood's article was no help, particularly since the example program was written in C.

I find the plus (+) key near the numeric pad to be just about useless. At the same time, when entering data into a BASIC program, I would like a comma I can reach from the numeric keypad. The obvious solution is to change that plus key to a comma. An article that showed how to do that would be really helpful.

Michael Trombetta  
Manhasset, New York

Kenneth Wood replies:

I sympathize with Michael Trombetta's difficulties in attempting to redefine keys while in BASIC. After considerable experimentation, I found that BASIC bypasses the operating system to get its input characters! Therefore, the translation facility is unworkable for BASIC interpreters.

By the way, both plus keys are represented in the table by the same ASCII character: Change one and you change

the other. Below is a copy of a BASIC program that should have changed the plus to a comma and a C program that actually does it. The program discussed in the article was not intended to redefine any key, just the function keys and their shifted, control, and Alt values. Examples are in the DOS manual and everything in the program I wrote was based on information presented on page 13-10.

```
#include "stdio.h"
#define ESC "\033[43;44p"
```

```
main()
{
    printf(ESC);
}
```

```
"C" program to change "+" to ","
10 S$ = CHR$(27) + "[43;44p"
20 PRINT S$;
30 END
```

BASIC program that should perform the same function.

## Putting the Byte on the PC

More and more manufacturers are producing hardware that is allegedly IBM PC-compatible, but Zenith Data Systems seems to have put some teeth into the competition. According to an announcement in a University of Michigan research newsletter, Zenith's IBM PC-compatible Z-100 microcomputer has disk drives fitted with uppers and lowers to accommodate "double-dentistry" floppies. The possibility sounds intriguing, and I wonder how it works.

Although this hardware allegedly will operate under PC-DOS, maybe there will be minor variations in DOS commands: EAT instead of DEL or ERASE? DISKCHOMP in addition to our old friend DISKCOMP? Will there be a new BASIC command called BLOAT in addition to BLOAD?

All this doesn't sound too bad, but it may cause quite a mess when working

on WordStar and other programs that sometimes give DISK FULL errors.

Aside from lots of word processing, I use my PC for statistics. It's patched via modem to the University of Michigan's big Amdahl. This works well, but after all the number crunching I have to take the results of my stat analyses and "digest" them to see what they mean. Maybe the Z-100 will not only process numbers but digest them as well.

Although this new model may take a byte out of the IBM-PC compatible market, I think I'll keep my PC.

Marshal Shlafer  
Ann Arbor, Michigan

## On Gremlins and Graphics

Congratulations for what must be a record for responsiveness to a reader's request. In PC, Volume 1 Number 11, where you published my letter about keyboard troubles ("Keyboard Katatrophes"), your four cover stories dealt with diverse aspects of my problem. In the end, my "random" even numbers were cured by plugging the system unit into a different circuit.

In spite of all my precautions to avoid electrostatic shocks and to remove most surges and spikes using a Lemon, my PC was unable to handle a 10 volt bias on the nominal ground. Incidentally, I wrote to Boca Raton about this at the same time as I wrote to you and I got a telephone call within a week. Not bad.

I second Bob Davis's motion in "Letters To PC" (under the heading, "Designer Graphics," PC, Volume 1 Number 12) to identify graphics system characteristics more specifically. Changing "eyebrows" may help, but we need to know if devices or programs are compatible with the NAPLPS or GKS standards.

For example, one of your advertisers, Conographic, seems to be inspired by the NAPLPS approach (a sort of super-ASCII for graphics), but never specifically mentions this emerging standard in its litera-





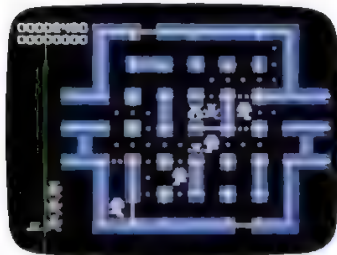
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# Letters To PC

ture. The whole question of how to transmit real (not ASCII-character) graphics over phone lines is still up in the air, and most of the products reviewed in Volume 1 Number 12 can't be used with communications programs.

R.J. Rahn  
Ste-Foy, Quebec

See "Exporting Graphics With NAPLPS," PC, Volume 2 Number 2—Ed.

## The DOS Dossier

After reading David Rose's review of IBM's new operating system, DOS 2.0 ("DOS Marches On," PC, Volume 1 Number 12), I had to ask myself who the drummer in this case should be.

Anyone with experience on the Honeywell Level-6 minicomputer, using the GCOS6 operating system, could not help but notice the similarities between it and DOS 2.0. The concepts employed in DOS 2.0 reflect and sometimes almost duplicate concepts used in GCOS6, which has been a highly successful product for Honeywell.

The release of DOS 2.0 should therefore prove highly successful for IBM, especially since it is priced so modestly. With a little practice and planning, a user now has the capability of a more state-of-the-art data management function, which had been lacking in the past.

When I finished reading Rose's article, several unanswered questions still lurked in my mind: Is DOS 2.0 really IBM's prototype for a more sophisticated operating system, perhaps conceived to replace the outdated operating systems used on IBM mainframe computers?

Is it a marketing strategy to undercut the Honeywell PC base? Little is known regarding Honeywell's PC other than that it is oriented to the business user only.

Has Big Blue finally decided that, in the end-user demand for user-friendly systems, "if you can't beat 'em, join

'em," and utilize the concepts of a proven product?

Robert E. Pretti  
Saint Louis Park, Minnesota

## Far East Fair-Hopping

In "PC-Communiqués," PC, Volume 2 Number 1, you mentioned electronics shows in Japan, Taiwan, and Hong Kong during October 1983. Can I get more details on these conventions?

Gordon M. Greenblatt  
Phoenix, Arizona

For further information about these and other Asian electronics shows, contact the following sources: the Japan National Tourist Organization, (212) 757-5640, and the China External Trade Development Council, (212) 532-7055.—Ed.

## Frustrated in Cleveland

Great "book"; I love it. But please let readers know whether a tested program requires a color board. This is very frustrating for those of us who only own the IBM monochrome board.

Russell J. Logan  
Cleveland, Ohio

We try, for every product we review, (or even mention), to include a summary box specifying requirements. If the software requires a color/graphics adapter, or a monochrome adapter, or a left-handed operator, we'll say so. Unstated means it will run on any ordinarily equipped PC.—Ed.

## Founding a Users Group

I have been asked to start a computer club at or near a local community college to benefit college students, individuals, instructors, and local businesses. I have never done this before, but I am experienced and employed in the industry, and I would like to help.

My first guess is that we can set up a group initially as a nonprofit organiza-

tion and purchase an IBM PC shortly through membership and usage fees. Can you help us? I believe we can start small and grow with the proper guidance and assistance from existing clubs.

Walton T. Brown  
Los Angeles, California

You're on the right track. See "How To Start A User Group," PC, Volume 1 Number 10. Also check our PC User Group listing which runs in every issue for an existing group in your area, and ask the members for help. Good luck!—Ed.

## Comparison Shopping

Why do you always compare word processing software with other software? Why not compare it with Wang or Lanier programs so we would know how they really compare to the word processors that have set the standards for the business office?

Larry Grimenstein  
Cincinnati, Ohio

Our purpose is to serve the needs of IBM PC owners and those with an interest in the field. If you are shopping for a word processor for your PC, the only things that really matter are the relative merits of the available software. However, when we have an instance of a product with a mainframe, minicomputer, or microcomputer equivalent, we do draw the comparison, as we did with MultiMate, a Wang-like word processor.—Ed.

## Return To Sender

In "Avoiding The Worst" (PC, Volume 1 Number 11), Winn Rosch states that dust covers for the IBM PC are available from a company in South Gate, California, Microcomputer Accessories, Inc.

I have mailed a company check for the stated cost of the disk cover and companion keyboard cover to the address printed in PC. My request for the merchandise was returned stamped "Not

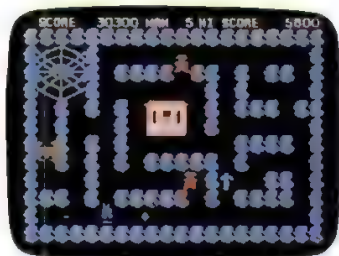




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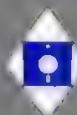
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# Letters To PC

**Deliverable as Addressed.** I have attempted to call Microcomputer Accessories, Inc. but there is no telephone listing for it in South Gate.

I would still like to obtain the dust covers. Moreover, I'm curious to know how a magazine of the size and reputation of PC could print the address of a company that is either impossible to contact or nonexistent.

Can you supply me with any more information concerning Microcomputer Accessories, Inc.?

Julia Conn Watt  
Lawrence, Kansas

**It's not our fault;** Microcomputer Accessories, Inc. has moved. The company's new address is 1545 Pontius Avenue, Los Angeles, CA 90025, (213) 477-4216. The keyboard cover is still \$12, as the article stated, but the disk drive cover has gone up to \$10. There's also a \$3 shipping and handling charge.—Ed.

## I Can't Believe What I Am Reading!

I am shocked and amazed! If there is anything in the world that computer addicts, from T.V. typewriter amateurs to C-language programmers, agree on, it is the prescription that economical and accurate use of language cannot be compromised.

Thus, it is with much consternation that I point out the continued misuse of the word data. Data is the plural of datum. Data are!!! Datum is! One can legitimately say, "The database is inadequate," but one emphatically cannot say, "The data is not considered adequate."

This pervasive linguistic bug is all the more surprising given the influx, caused by widespread use of microcomputers, of people who author more than just FORTRAN programs. Worse still is the fact that many scientists utter phrases such as "This data indicates that. . . ." The proper use is, "These data indicate that. . . ."

This is not simply a debate between language purists. To use the plural of this noun without the correct form of the verb to be is simply wrong. I do not expect all comp-heads to know rules of grammar, but editors can make no excuses. Our business is based on accurate syntax and grammar. It is a shame we don't pay more attention to our English.

Chip Clarke  
Stony Brook, New York

Data are. You're right. Sort of. Your letter is a salvo in the unending conflict over the mutability of English. We know, of course, that the word data is the plural of datum (just as media, phenomena, and stadia are plurals of medium, phenomenon, and stadium respectively). However, inasmuch as English lacks a central authority, we take refuge in the pronouncements of Webster, who, regarding the word data, rather cryptically notes, "pl but sing or pl in const." We would like to preserve data as a plural. The tide is against us. Data is.—Ed.

## Non-Compatible

I committed myself to a 3-year subscription to PC Magazine because I believed that you were "The Independent Guide to IBM Personal Computers" as you claim. You must realize that most of your subscribers own IBM PCs and recognize that machine as the finest personal computer ever built.

I (and I assume we) do not want to hear about compatibles! You promised me a guide to the IBM PC. Do me a favor and cut out the compatible articles.

Thomas W. McGonegal, Sr.  
Underhill, Vermont

Very much part of the story of the PC is the sub-industry that has sprung up around it. Some of the "compatibles" go IBM a step or two better; others undersell the product. We define a compatible as a device that will run the same soft-

ware as an IBM, accept the same hardware add-ons, and (necessarily) offer the purchaser another choice in the marketplace. We think that's all part of our role as "The Independent Guide to IBM Personal Computers."—Ed.

## Shifting Bands

In Stephen Manes's article, "Toward More Colorful Printing" (PC, Volume 2 Number 1), he mentions that he uses an IDS-132 Prism printer with the color option. This is the same printer that I use with my IBM PC, and I also use an all-black ribbon most of the time.

I would appreciate any help you can give me as to how I can shift through all four bands of the ribbon. My dealer was no help. Most of my printing is done with SuperCalc. Can the shift be input through the SuperCalc print option? Is there some setting I can adjust on the printer so that it defaults to a specified band whenever it is used?

Stanley Topper  
Long Beach, New York

Stephen Manes replies:

Getting a color Prism to shift through the four bands of a black ribbon isn't hard. First make sure that switch 7 of the left-hand bank of DIP switches is ON (toward the front of the printer). Then turn the printer on, put it online, and be sure it's not out of paper. Finally, enter BASIC and run the following program:

```
10 LPRINT CHR$(27); "Q,5,$"
```

Until the printer is turned off or you send it a contravening command, it will then automatically shift ribbon bands at the end of each page. For convenience, save the program as RIBBON.BAS and put it on a disk with BASIC. Then you can run it from DOS simply by typing BASIC RIBBON.

You can also force the printer to use any individual band. Just replace the 5 in the above program with a number from 1 to 4. 1 is the equivalent of the yellow band, 2 the magenta, 3 the blue,



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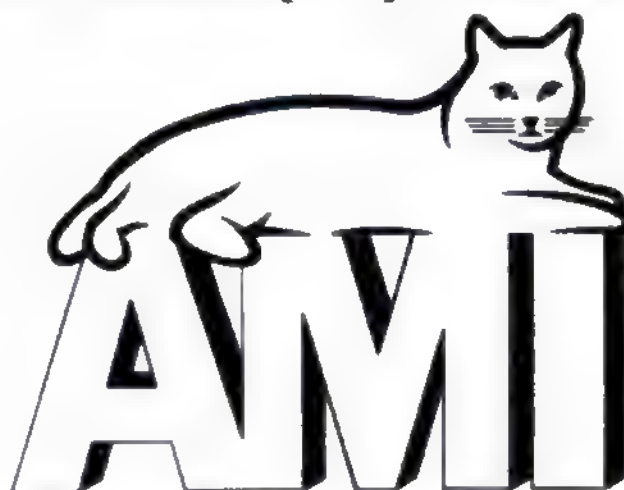
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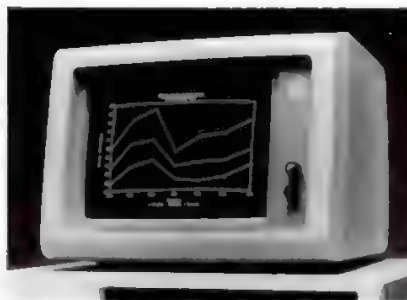
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# Letters To PC

and 4 (the default) the black.

I'm not familiar enough with SuperCalc to know whether this can be done directly from that program. If it, like WordStar, has room for a "printer initialization string," you could patch hexadecimal values into that section. The values you'd need for ribbon shifting would be 1B 51 2C 35 2C 24—equivalent to the program listing above.

And your dealer should have known every word of this. Write a BASIC program that will play an endless loop of Bozo the Clown's theme song and chain him to a machine that runs it.

## A Colorful HALO

In his article "Three Alternative Graphics Boards," (PC, Volume 2 Number 2), Bill Machrone discussed Orchid Technology's MGA Board and its graphics software, HALO.

As the author of HALO, Media Cybernetics appreciates the favorable review PC gave our product. However, we would like to correct an error regarding HALO's capabilities. Machrone wrote, "HALO provides a number of sophisticated ways to fill or flood shapes and it will probably be able to support full color operations someday, though it is currently available only in monochrome."

HALO was originally designed for and is currently available on high-resolution color graphics boards. Scion's PC640 and the Amdek MAI Board both provide HALO as their graphics software. In addition, Lifeboat Associates distributes a version of HALO that supports the IBM PC standard Color Graphics Adapter.

HALO, which was first shown at the Fall 1982 COMDEX, does indeed support color. In fact, HALO extends the color capabilities of graphics boards it supports. Advanced dithering and hatch fill functions provide 10 shades of color on the IBM adapter, 125 shades on the Scion PC640, and 125 in Amdek's

320×400 mode (10 in 640 × 400).

William E. Strum  
President, Media Cybernetics, Inc.  
Takoma Park, Maryland

Bill Machrone replies:

Thank you for clarifying HALO's color capabilities. My first exposure to HALO was in conjunction with the Orchid board. Subsequently, I have had a chance to use it with the Scion board as well and have gotten a full appreciation of its color capabilities. We have not yet tested the version that works with the IBM color/graphic adapter, but hope to do so in the near future.

## Gonna Be Some Changes Made

A letter by one of your readers addressed the issue of consumer advocacy groups for computer users ("End-Users, Unite!," PC, Volume 2 Number 1). The Better Computer Corporation (BCC) has been founded recently to provide consumer services to PC owners. BCC is a nonprofit organization, created to assist consumers and companies alike.

We at BCC would like to see a change in attitude among those giants who never would have made it if we, the consumers, had not invested in their products and services. Our purpose will be to address the needs of dissatisfied buyers by compiling information based on letters of complaint. We will mail to any party who requests it a summary of the complaints that have been issued against a particular firm. All the conditions and relevant information will be provided in a basic kit available to anyone who asks for it. Please send a self-addressed stamped envelope; we are in the process of receiving approval from the Postal Service to mail free literature and information in the future.

We ask all PC readers to voice their complaints to us. We will do everything possible to help them by making these complaints public through private mailings, by publishing a "Top 10" chart for

the worst service on a monthly basis, and, most important, by informing the firms in question of their performance.

We are starting to build a database of information on companies and products that have had problems with consumers in the past. One company's file is nearly as big as PC Magazine itself! We request that all letters submitted to us be submitted to the company that caused the complaint as well.

Our address is: Better Computer Corporation, 10301 Holly Hill Place, Potomac, MD 20854.

Farid N. Ghadry  
Potomac, Maryland

## Educational Software

In response to Margene Todd's letter ("Software for Students," PC, Volume 2 Number 1), we currently have six educational programs for the IBM PC. EDU-BASIC I and II teach how to program in BASIC. EDUMUSIC I and II teach about music, and the KEYBOARD PIANO converts an IBM PC into a piano keyboard. EDUCHESS teaches chess. For more information give us a call at (707) 763-9700 or write to EuroPro, Inc., 129 Saratoga, Petaluma, CA 94952.

Michael Degive  
President, EuroPro, Inc.  
Petaluma, California

## Over There

In Kathleen Burton's article "Over There: IBM In Japan" (PC, Volume 2 Number 2), she discusses a famous Japanese actor. The correct spelling of his name is Kiyoshi Atsumi (not Kioshi), and the name of the film series is "Otoko wa Tsurai Yo." A better translation is "A Man's Life is Hard." I belong to a Hawaii IBM PC User Society, and I called some of our members in Japan to double check this. I suspect Burton heard actor Atsumi-san's name pronounced, rather than having read the characters. But her description of Atsumi-san and of the films



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# Letters To PC

is excellent.

The photo accompanying her article is typical of how Atsumi-san often looks in the Walter Mitty-like dream sequences that open up each movie. There are now 31 movies in the series. The protagonist's name is Tora-san (a nickname meaning tiger; his actual name is Kuruman Torajiro-san). The films are excellent travelogues of Japan, as Tora-san is an itinerant salesman, usually drifting from one festival to another, selling whatever cheap goods he can pick up wholesale. His sales patter is something to behold!

His hometown is Shibamata in Tokyo, a few blocks from the Ara river (Arakawa in Japanese). Our Society's Cinema SIG made a pilgrimage to Shibamata during our semi-annual meeting,

held in Tokyo last summer. It seems to us that its only a matter of time before a PC shows up in a Tora-san episode.

Arthur W. Becker  
IBM PC User Society  
Pearl City, Hawaii

## How to Write to PC

Please send all submissions for "Letters To PC," "User-To-User," "PC Tutor," or "PC-Communiqués" to PC Magazine, One Park Avenue, New York, NY 10016. New Product announcements should be sent to "New On The Market" at the same address. Please indicate the correct department on the outside of the envelope.

All material submitted is subject to editing.

## Corrections

Jared Taylor, author of "The Bottom Line Strategist" (PC, Volume 2 Number 3), has brought the following correction to our attention:

According to Taylor, he incorrectly criticized the program for failing to reinvest positive cash flows or to remunerate capital. Though neither of these operations is specifically included in the reports that Ashton-Tate's Bottom Line Strategist (BLS) generates, both are implied by the net present value method that BLS uses to evaluate projects.

In effect, all capital, both debt and equity, is remunerated at the cost-of-capital rate, and positive cash flows are reinvested at the same rate. This is a perfectly proper financial forecasting technique and Taylor was incorrect to suggest that neither operation was taking place.

The program, *Family Reunion*, by Personal Software Co. of Salt Lake City, can keep data on hundreds of generations, not just six ("New On The Market," PC, Volume 2, Number 2).

In "The Empire State Strikes Back," PC, Volume 2 Number 2, the photo appearing on page 509, should have been credited to the New York State Department of Commerce.

In "Remote Possibilities: The Latest Line On The Heavy-Baud Bout" by Stephen Manes (PC, Volume 2 Number 2), there was an error in Figure 2, item 5, on page 364.

Line 5260 should read:

```
5260 GOSUB 2500: IF Q$=CHR$(27) THEN GOSUB 2655:GOSUB
      2655:ABORT=-1 ELSE IF Q$("<")="" THEN DT$(I)=Q$:IF
      DT$(I)=" " THEN DT$(I)=""
```



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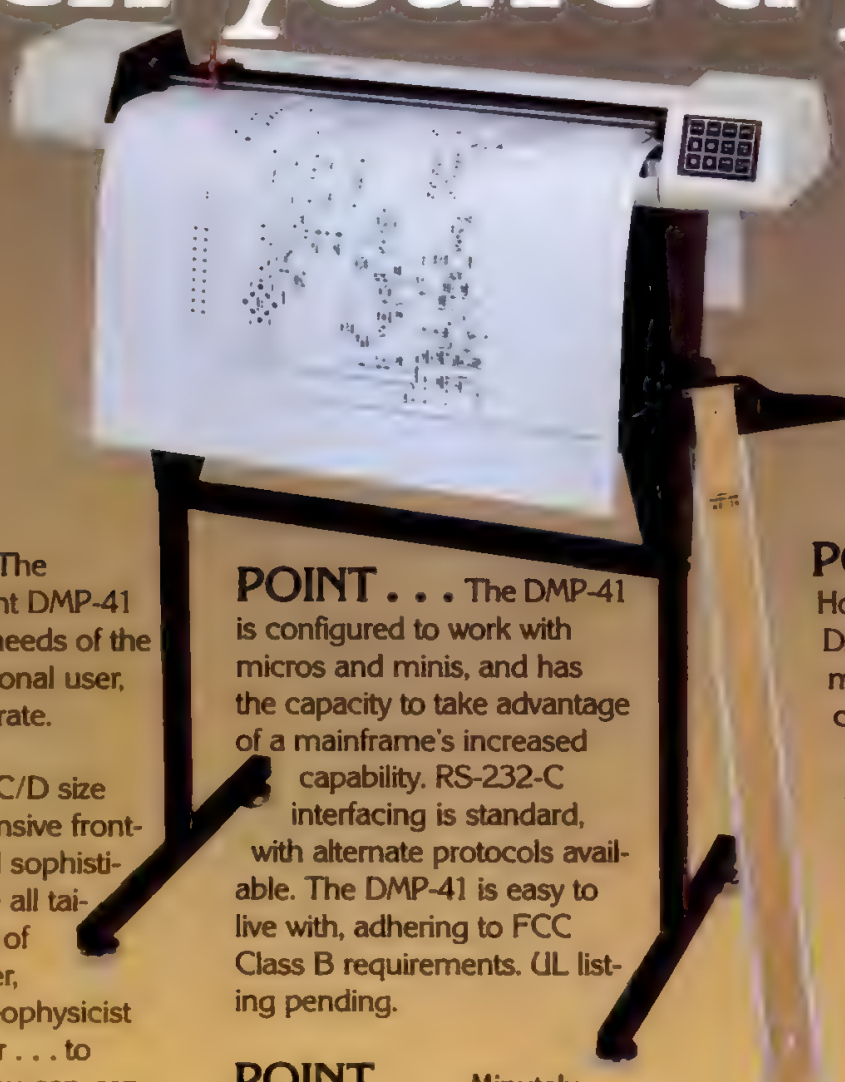
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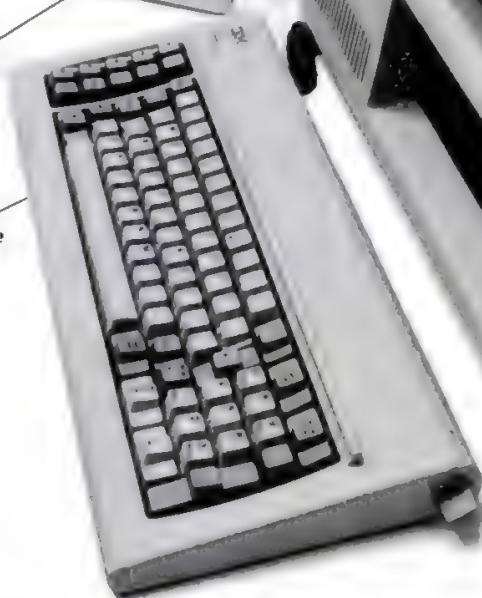
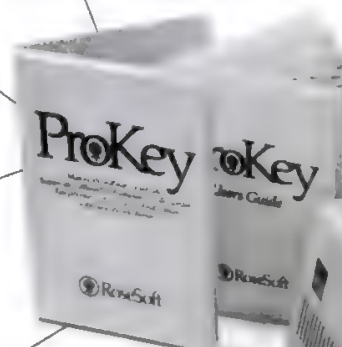
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# PC-Communiqués

A compendium of facts, news, opinions, gossip, inside intelligence speculation, and forecasts about IBM Personal Computers.

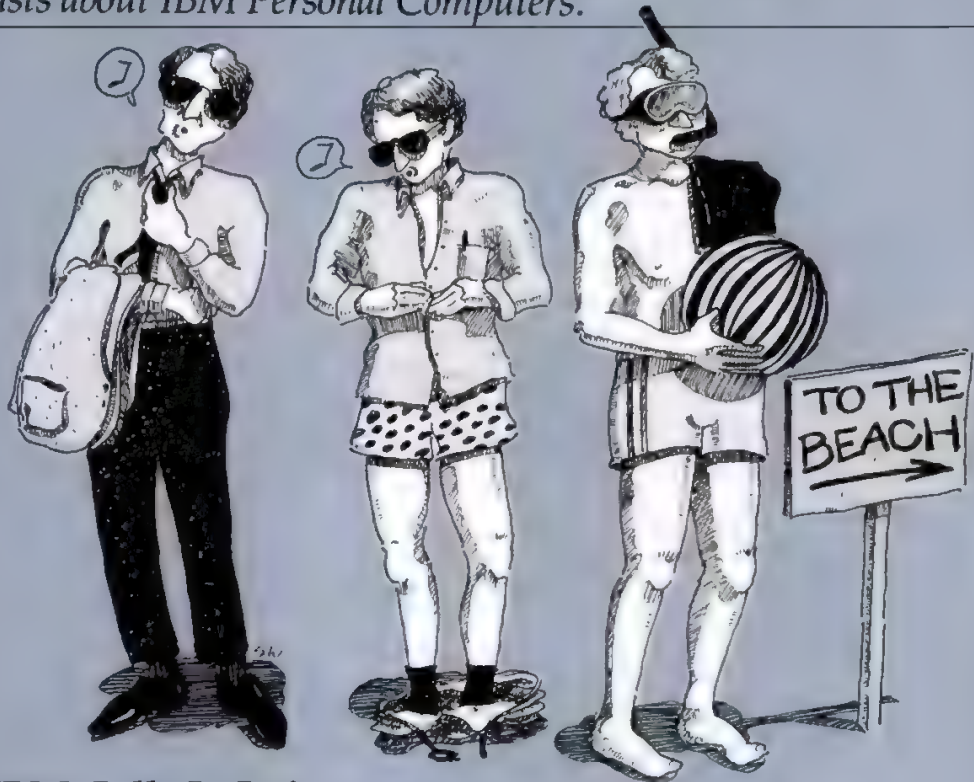
## Bonjour, PC!

In France—birthplace of the kilo—a byte's called an "octet." Gendarmes recently raided a computer club to stop its illicit copying activities in Issy-les-Moulineaux. And you can buy a personal ordinateur named Leanord, Logabax, or Yrel. But what about the IBM PC, which has been available in France since the beginning of 1983?

Despite the title of the magazine for its French users—*l'Ordinateur Personnel*—it's called a PC, not an OP. The French machine's nameplate still says "IBM Personal Computer." But, according to the magazine's report, French users get a 6-month warranty instead of our paltry 90-day coverage.

They also get a Gallicized *clavier*—keyboard to you—that employs the French-standard layout known as AZERTY (these letters appear where we expect to find QWERTY). The keyboard also puts most accented vowels in the top row; to get numerals you have to use the shift key. Still, keys with such labels as Home, End, and Caps Lock should cause eyebrows to arch at the Académie Française—these words are hardly French.

Neither are the shift keys. *l'Ordinateur Personnel's* reviewer complained that they're "bizarrely located and will disorient those used to traditional



## IBM Calls It Quits

We were shocked to read the news that the computing colossus decided to cease production of all products. Why this startling move? The corporation was bored. "My products simply sold too well. All we had to do was put my name on it and people signed up. There was no marketing challenge."

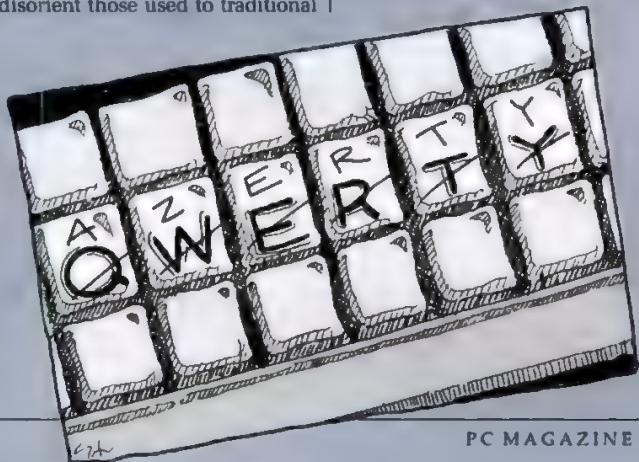
Our fears over continuing to find a livelihood at PC were allayed when we noticed that this news item appeared as the lead story in *Confuserworld: The Newsweekly for the Confused Community*. This 36-page parody tabloid is the best of the lot of computer humor items that have appeared recently. To find out more about Kitchen-Net (the local appliance network) or Leon Spinks' secret life in data processing ("No More Head Crashes"), send \$3 per copy to Confusion Inc., P.O. Box 5177, Palo Alto, CA 94303.

keyboards." Apparently IBM's oft-repeated claim that the PC keyboard's unusual arrangement is a "European standard" just isn't the case.

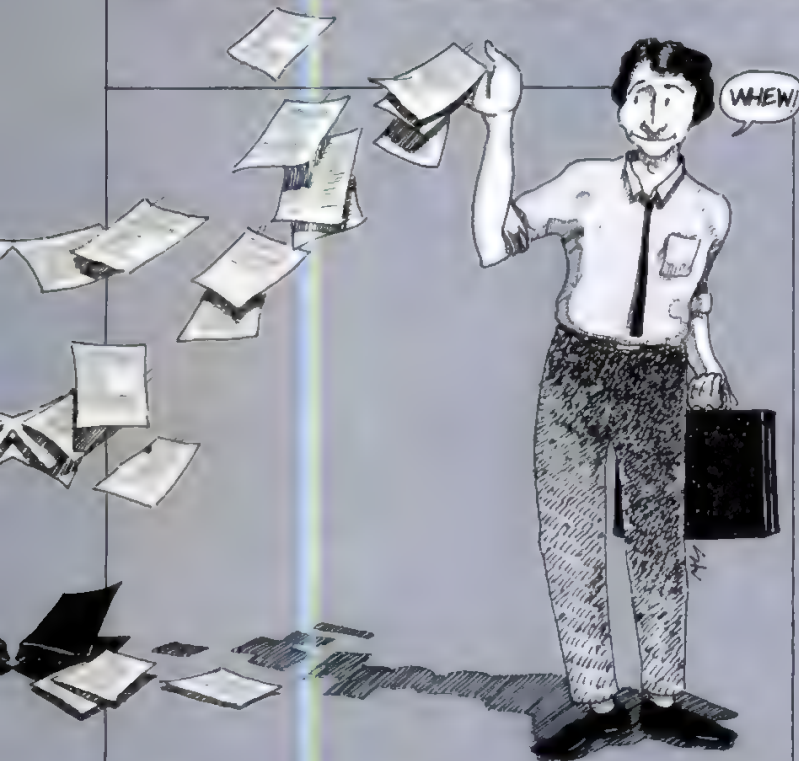
Some other remarks in the magazine will sound familiar to those American users who remember the PC's early days. While IBM itself only offers two programs—*Easywriter* and *Multiplan*—"Every week someone announces a new program 'available for the IBM PC,' but it's impossible to see it run, let alone try it out. . . . While

we're waiting, the Personal Computer is an empty box." Shades of early-1982!

*l'Ordinateur Personnel* interpreted IBM's corporate policy this way: "We don't make the biggest computers in the world; we sometimes get left behind technologically, but we satisfy our customers—any way we can." The magazine sums up IBM as "Dieu le Pere, en trois lettres." This *mot* loses a little of its effect in the English equivalent: "God the Father, in three letters." —Steven Manes



# PC-Communiqués



## Farewell, Manual!

One of the most wonderful statements in the history of computer documentation can be found on the third of ten pages of the operating manual for the SC817 Smart Cable made by IQ Technologies, Inc. After the fifth and last step of "How To Set The SC817's Switch," the manual tells you, "If the data transmitted is garbled, go to the 'RS232 System Debug Checklist' " on page 3.

"If the data transmitted is correct, congratulations. You are finished. You may skip the rest of this manual."

Now that's the kind of planned obsolescence we like to see.

## Furnished For Computing

Clearly not all computers are locked away in dark corners of dens and bedrooms. In a recent survey of members of the American Society of Interior Designers, 15 percent said they spent a significant amount of time adapting homes to accommodate computers and related hardware—only 2 percent had in 1980.

Calling in a team of expensive experts may be a bit ambitious for most people, but there's still room for home improvement. In

PC Magazine you'll find suppliers of elegant dust covers for diskettes, wood-covered cabinets for monitors, stands for printers, and desks for keyboards.

With all this ergonomic furniture, a family in a house that's been designed around a PC may be an indestructible unit. Could you or your mate face the prospect of breaking up your happy home if it meant divorcing a beloved printer from its walnut cabinet? If your answer is "yes," we offer this advice: If you plan to hit the road, Jack, forget the furniture and grab a Compaq.

—Karen Cook

## A Numbers Problem

Do you really want to know how many PCs IBM has sent out into the world? Here's the latest official non-answer from Big Blue itself.

According to a highly placed spokesman in the company, IBM has shipped out more PCs

through May 31 of this year than it did in all of 1982.

This phrasing reminds us of the old math puzzles that went something like: When I was 25, I was twice as old as my uncle. My uncle then was three times as old as my sister. And my mother now is 56. How old will I be in 3 years? Give up? —Corey Sandler

## First Class Mail

The Keeper of "Letters To PC" mentioned that she was disappointed by how few interesting letters have come across her desk. It's easy for her to expect better when she sees Car and Driver, our neighbor down the hall, receive the makings of the most lively letters column in any periodical.

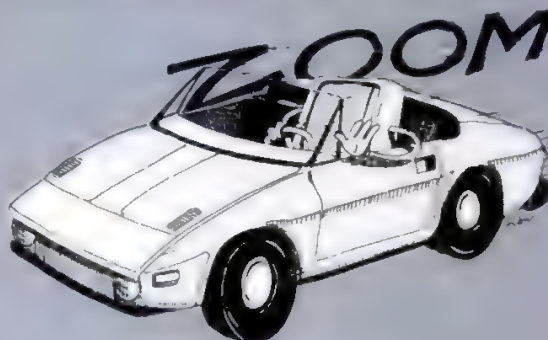
So why does PC—one of the world's thickest magazines—get relatively few letters from readers? Is it because most of you have no time left to write after working through 600+ pages every month? Are you waiting until somebody builds a better word processor before you catch up on your correspondence?

Whatever your reason for not writing, it's probably nothing that money wouldn't cure. We want to see some better letters so badly that we're willing to offer a bribe—your choice of any word processing software advertised in PC. Just be the one reader who sends us the best letter (in our estimation) that arrives in time to be printed in PC's December 1983 issue.

What makes a good letter? If something you read in PC strikes a nerve—for good or ill—just tell us about your own experience and thoughts on that topic. If you feel you need more guidance, look at Car and Driver.

All letters we receive before the deadline will be eligible for the prize. But, if you think you've written a winner, you might catch our eyes by addressing your missive to "Better Letters To PC," PC Magazine, One Park Avenue, New York, NY 10016.

And children. Children! After writing to us, pull out another piece of paper and send a letter to your parents. It won't take more than a moment and it will make them feel so good. They might not be offering a prize, but they're waiting to hear from you.





## Pay No Attention to the Monitor Behind This Sign



Sure, IBM wanted to talk about its Series/1 Videotex System at a recent show in New York. IBM's flashy exhibit included PCs that were connected to Prestel in England and that displayed NAPLPS images (see "Exporting Graphics With NAPLPS," PC, Volume 2 Number 2). The crowds listened to the earnest demonstrator posed in front of a huge rear-projection television screen as he explained Big Blue's announced intent to link its PCs and Series/1 minis into the "video and communications revolution of the 1980s." But, the public's eyes kept drifting to the left to a pair of diminutive color screens with pint-sized keyboards. . . .

Encased in a form-fitting plastic case, smaller than a breadbox, were two 9-inch (diagonal measure) color RGB monitors with untitled IBM nameplates. The image was sharp and crisp and just perfect for a (HUSH!) portable computer.

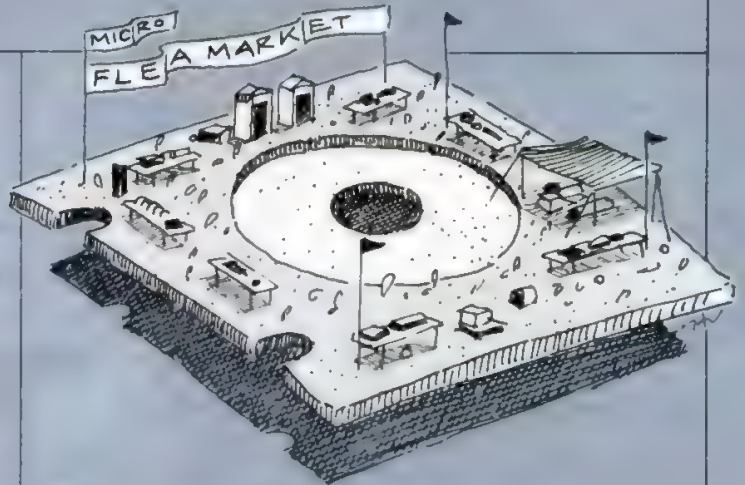
IBM must have anticipated the ensuing barrage of questions; the monitors were assigned their very own PR man, programmed to deny that the devices had any significance whatsoever. He kept pointing to a printed card on the stand: "This prototype device

was built by IBM to demonstrate the feasibility of various Videotex/Display functions. IBM makes no representation that these functions will ever be available commercially."

But the questions kept coming, including a few from a crew of Japanese businessmen. Was this a glimpse at part of an upcoming IBM micro-micro? They wanted to know—now.

Well, of course, the man from IBM shrugged them off. The two monitors on display are the only ones Big Blue has assembled, he said. The case came from the 4704 Banking Display. And the picture tube, he allowed, was a Panasonic. This admission pleased the Japanese businessmen who, as it happened, were from Panasonic.

—Corey Sandler



## Micro Flea Market

Computer Swap America is a series of 1-day shows (established 1976) featuring an exhibit of historical personal computers, door prizes, and amazing bargains from over 320 sellers—the prices of their wares sometimes drop wildly as the afternoon wears on.

Come to haggle over used microcomputers (and even minis), peripherals, software, automotive computers, and robots, while the radio-controlled blimp maneuvers over your head inside the Santa Clara County Fairgrounds.

The next Computer Swap America shows are September 10, 1983 and January 28, 1984, from 10 a.m. to 6 p.m. at 344 Tully Road, San Jose, California. For more information call (800) 221-SWAP, (415) 327-7810, or write to Box 52, Palo Alto, CA 94302.

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# PC-Communiqués

## Take Me to the Fair

The words "computer fair" bring strange images to a nostalgic mind: A carney barker on the midway calling out "See the sultan's plotter! It shimmies, it shakes, it turns yer eyeballs into knots! Only a quarter!" Or the touching sight of a young software author clutching her blue ribbon and a \$100 bill; but tears run down her cheeks as her program diskette is taken away to be compiled.

Today's computer fairs have little of the atmosphere of cotton candy, hay bales, moustache wax, and two-headed calves. Still, the following events dealing exclusively with the IBM PC may be to the taste of citizens of the Silicon State.

In Toronto, Ontario, the Skyline Hotel and Convention Centre will be the site of PC+2 on September 9 and 10, 1983. This show is sponsored by the Personal Computer Association (PCA) and the Personna Computer Association Inc. (an international association for IBM PC users). Contact Hi Tech Trade Expositions, P.O. Box 99, Ajax, Ontario, Canada L1S 3C3 or phone (416) 686-3866.

Then, from October 4 to 6, 1983, PC'83 will welcome you to Boston's Bayside Exposition Center. The source for more information is Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167; call (800) 841-7000 or (617) 739-2000 (in Massachusetts).

—James Langdell

## PC-Communiqués Pays

Do you have news, gossip, or unusual computer tales for "PC-Communiqués?" We will pay up to \$50 for each submission used. You must include your name, address, and telephone number with the item. We will preserve your anonymity if you wish. All submissions become the property of PC and are subject to editing. Our "User to User" section also publishes and pays for readers' submissions; that section features tips, problem solutions, and short programs or routines. Please send submissions to the appropriate department—"PC-Communiqués" or "User to User"—at PC, One Park Ave., New York, NY 10016.

## Strange Mail

You might think some items you read in "PC Communiqués" are strange, but the things we receive are often stranger. A few weeks ago the mail brought a plastic bottle to this shore. PC's writers and editors were disappointed to find that the bottle was filled with a press release rather than anyone's favorite fluid. (A list of

our preferred beverages is available to publicity persons on request.)

The paper and ink inside that bottle would have been of no assistance in washing down the handfuls of Crackerjacks we extracted from a box that accompanied another press release. (PR departments please note: Tastes in our office run more toward Pepperidge Farm

cookies and Godiva chocolates.)

The envelope that had us asking most quizzically the question "Why us?" was one that held a press packet, including photos, announcing Aqua Tunes—a waterproof belt and earphone that allows you to listen to a Walkman tape player and radio while underwater. Why was this product brought to the attention of a computer

magazine? Perhaps someone thought that PC was short for Pacific Coast? Or will we find that the next model of Aqua Tunes is large enough to enable divers to safely use their IBM PCs in the briny deep? Only the manufacturer can answer these questions; if you really want to ask, write to: Aqua Tunes, 1009 Grant St., Denver, CO 80203. Tell 'em Charlie sent you.



## Spelling Bug

Here's another tale with a moral that's worth repeating: Don't believe everything your computer tells you.

Conceptual Instruments Company was the beta tester for another software manufacturer's spelling checking program. In the course of preparing *The Desk Organizer* (a program reviewed by Paul Somerson on page 247 of PC, Volume 2 Number 2), the text of Conceptual's program was run through the prototype spelling checker.

While testing his copy of *The Desk Organizer*, our reviewer noticed that the work gauge, which appeared on nearly every screen of the program, was spelled guage throughout. He mentioned this to the manufacturer who recalled that the spelling of this word had been changed from right to wrong at the spelling checking software's recommendation.

This spelling bug was eradicated before either *The Desk Organizer* or the spelling checker (which prefers to remain anonymous) reached paying customers. However, we should all take this incident as a reminder that we shouldn't abandon our own eyes and memories.



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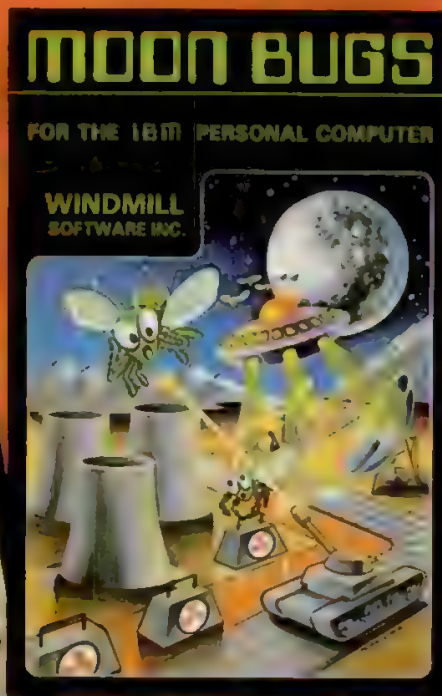
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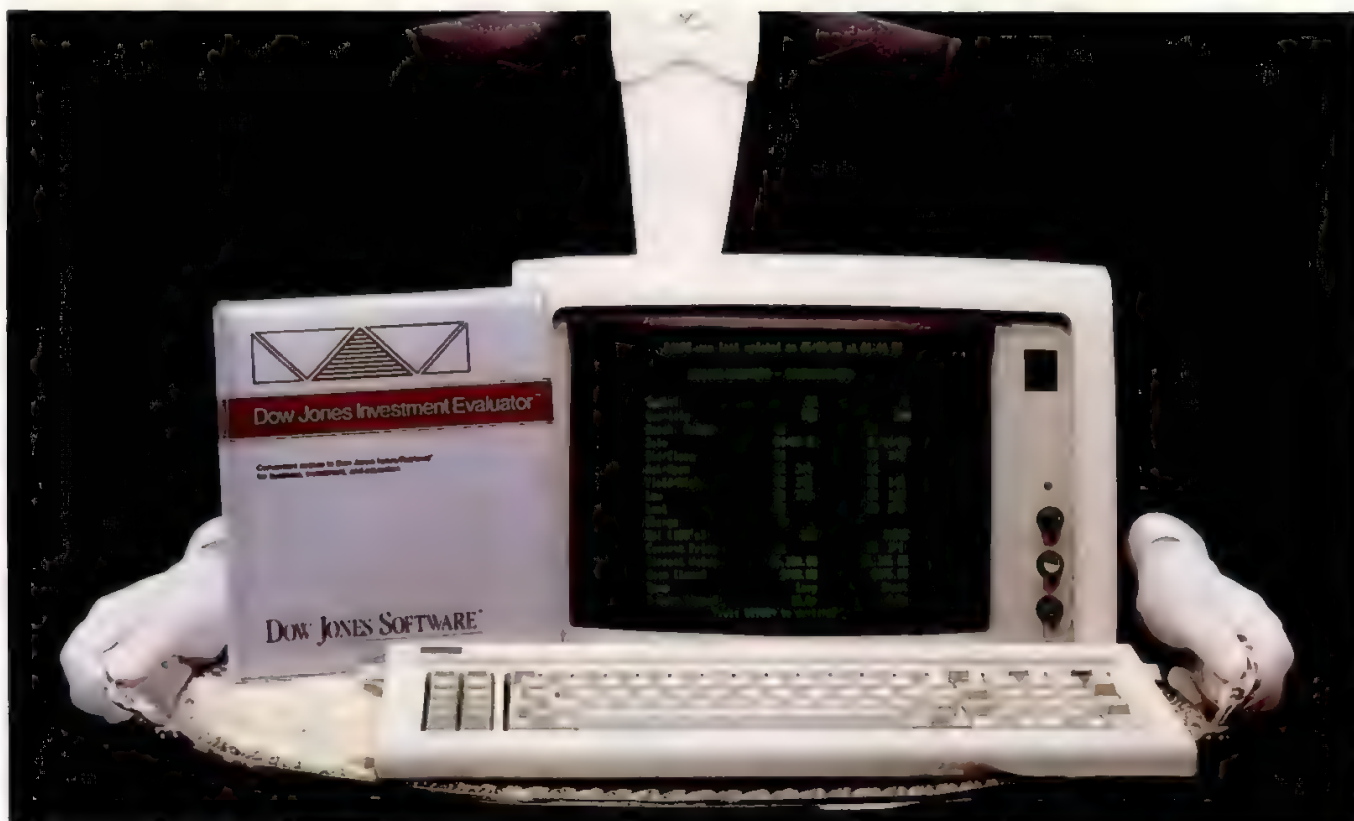
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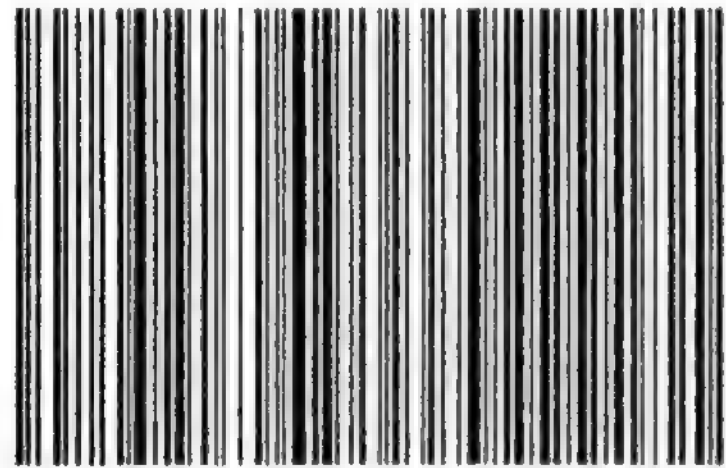
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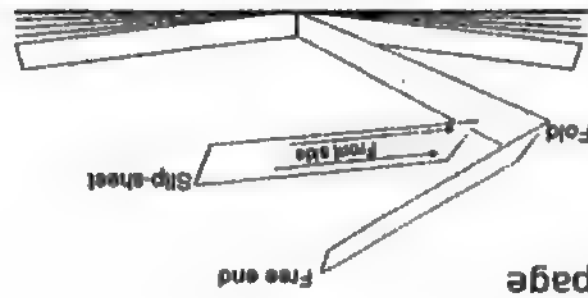
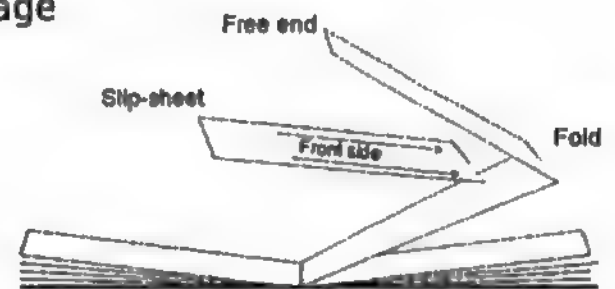
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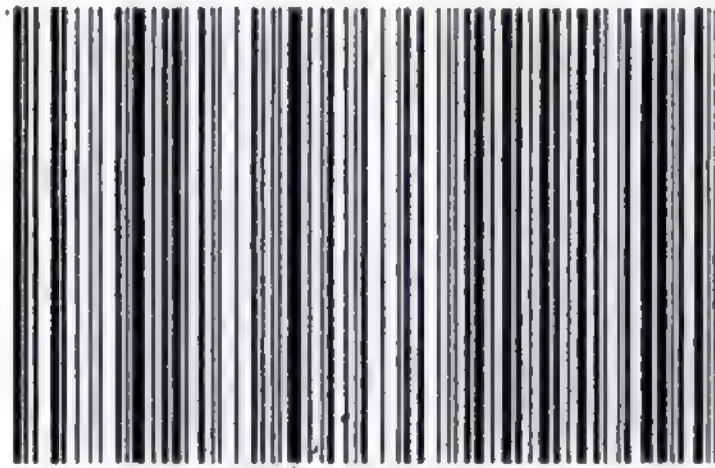
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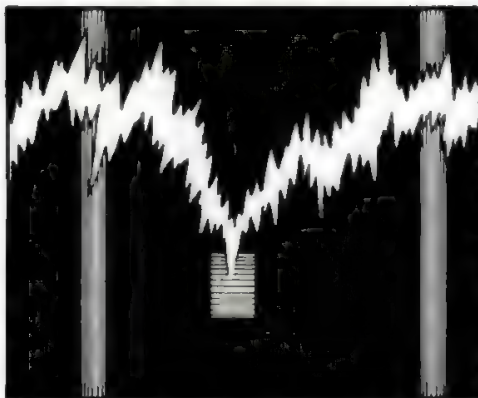


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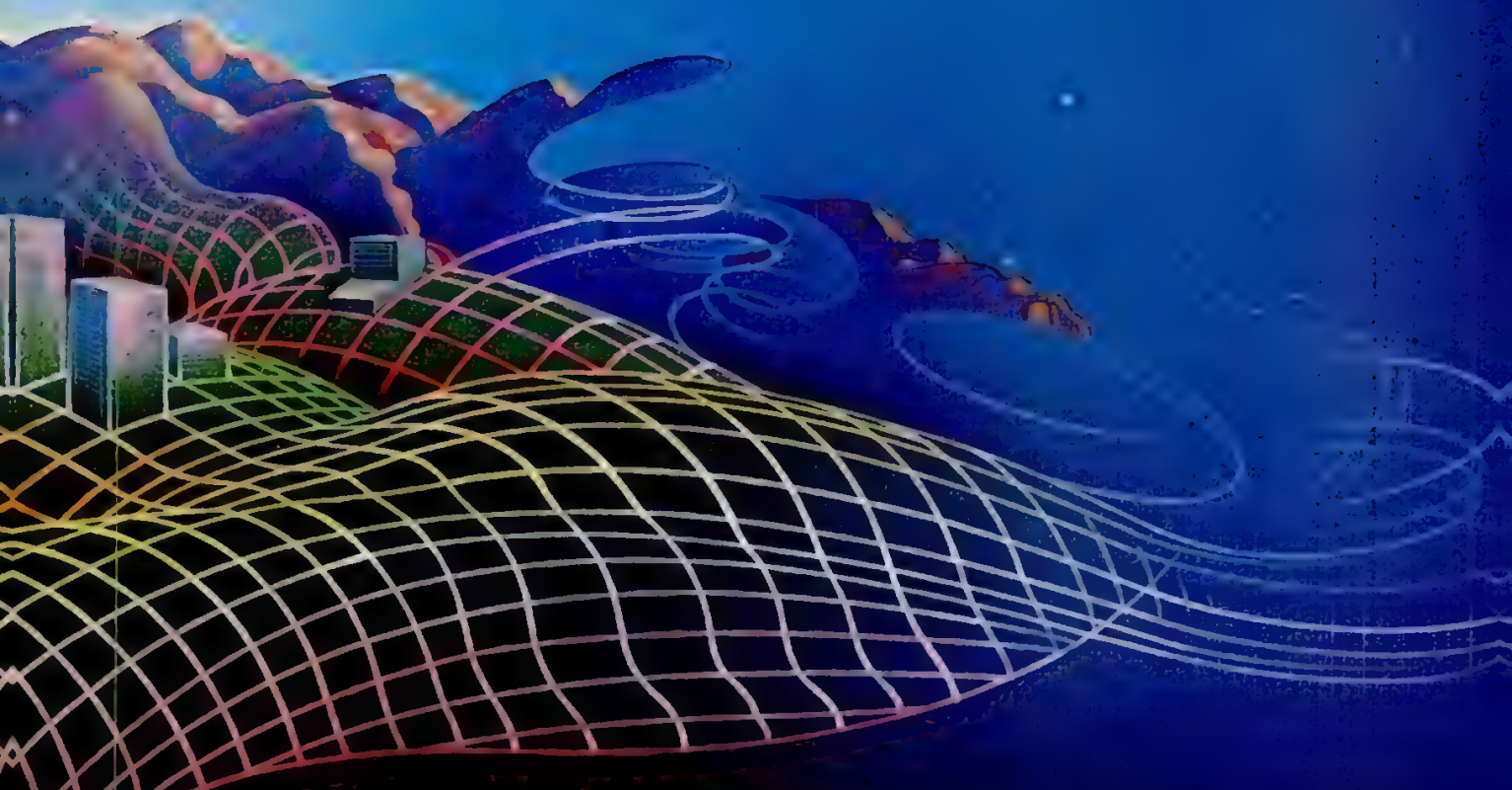
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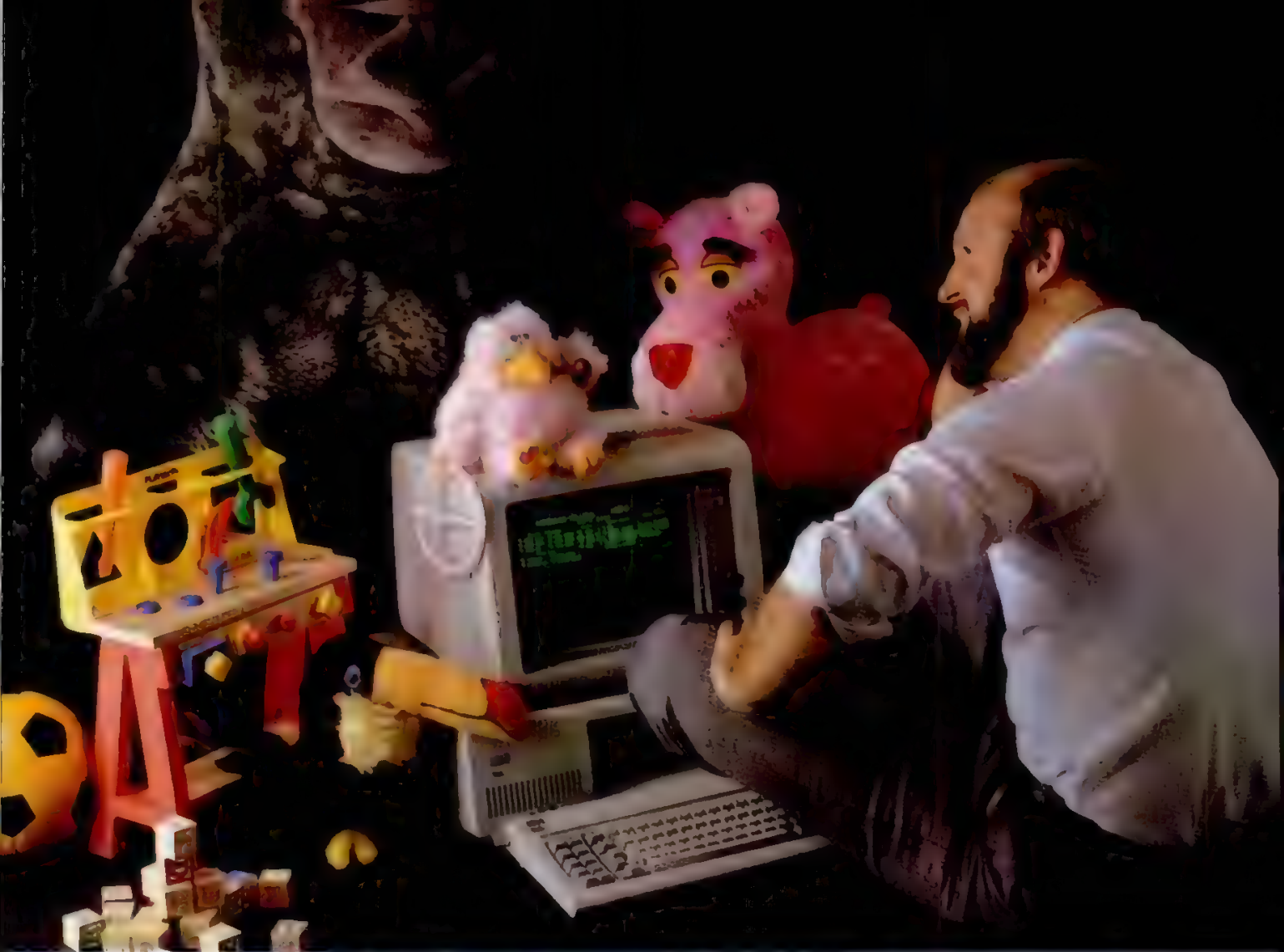
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*Norton began his involvement with computers more than a decade ago, starting with systems design, commercial applications and programming on mainframes for companies such as Boeing and the Jet Propulsion Laboratories. Born in Seattle, he now lives in Venice, California. His book, Inside the IBM PC, has just been published by the Robert J. Brady Co. (See "Peter Norton Tells All" in this issue.)*

*"PCs are the real future of computing and will chart the path for computer companies large and small," Norton said.*

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*We couldn't agree more. Welcome Peter.*



*Despite the growing list of computer languages available for the PC, only a few are capable of holding up to the ravages of time.*

# PC Languages: The Living And The Dead

This introduces a new column for PC, a regular monthly forum for topics technical and discussions philosophical about the rapidly maturing subject of computing related to the IBM Personal Computer.

We all have our individual contributions to make to the community of PC users; the one that I seem to be best able to make is two-fold: explaining some of the interesting technical aspects of the PC and drawing people's attention to philosophical issues in computing—issues that are easy to overlook and that can have important practical implications as new horizons open up with the PC.

Although the well of subjects to write about seems bottomless, I would very much like to invite your participation in this column, through suggestions of those things most worth discussing. Your involvement will be warmly welcomed.

The theme of this issue of PC is program development. One of my several activities is program development for the PC, which means that I have some battle-field experience to share in this area. So, for the first and probably last time, this

column will take on a personal element, as I tell you what I know about the touchy subject of choosing a programming language for developing programs.

## **An Embarrassment of Riches**

The subject of languages is touchy because most programmers—including me—have opinions that are distinctly individual and often passionately held. That the choice of a programming language can easily be an emotional issue is interesting and revealing in itself, but our topic is program development languages, not psychology (or barroom brawling).

I have often been asked what language I use for my own program development, and the fair answer to that question calls for a little history. When I began with the PC it was only a few months old, and there were only two languages available—interpretive BASIC and the Pascal compiler. At that time, not even the Macro assembler was ready. This circumstance didn't present a lot of choice, but it did provide a clear alternative. Interpreted BASIC and compiled Pascal are nearly as different as

any pair of languages could be, and so quite a bit of the territory of programming languages was being covered by this limited selection of two. For most programming needs it was quite clear which of the two was better suited to the task at hand; for my work, Pascal was the clear choice.

Although Pascal was more-or-less chosen for me (because there wasn't any real alternative) and although I had no previous experience with it, I soon came to deeply admire and respect the lean, crisp nature of Pascal and be proud both of the safety features built into the language and of the way it encouraged responsible, structured programming techniques. Now, with a year and a half of heavy experience with Pascal, I think of it, in general, as the choice programming language.

At this point I am usually asked, "So you do all your programming in Pascal?" and I answer, "No, I now do all my programming in C; I don't use Pascal any more." And therein lies the real rub of choosing a language for program development.



When I began with the PC there were two languages to choose from. Now, there are more than you can keep track of: Nearly every important language is available for the PC and many unimportant ones as well. Often, we have a choice of more than one implementation or version of a language. It is, as they say, an embarrassment of riches. Before, there was too little to choose from, while now, there is so much to choose from that the choice can be impossibly complicated.

To help reduce this complication, here is a combination of my best professional judgment and my personal opinion about the factors that should go into an intelligent choice of programming languages.

First, try to avoid being shortsighted. The whole world, including us, is investing billions of dollars in computer program development. We shouldn't squander this investment. Even when we only plan to use our programs for a very limited time and intend to throw our programs away, we should write them as if they were a precious resource that we would

want to make last as long as possible. The computer you use today won't be the one you are using tomorrow. The wise programmer uses a programming language (and the features of each language) that is likely to be available for many years on many computers. This is a strong argument against peculiar languages and homespun languages. In this regard, BASIC looks best (in the world of microcomputers); Pascal and C look very strong as well. Languages like FORTH and APL seem poor choices, while a proprietary language, available only from the language's creator, is the worst choice of all.

Another kind of shortsightedness is to choose a language that you are familiar with, or that you like, instead of searching for the language that is best suited to your needs. Here, I provide a good example to follow: I'm switching from a language that I deeply like (Pascal) to one that I'm uncomfortable with (C) simply because it is a better choice for reasons that we will see.

There are some reasons that would lead us to choose BASIC above all other languages. BASIC is a good choice for programs that may need to be modified "in the field," either to allow the user to do some customization, or to make it more practical to distribute corrections, patches, modifications, and improvements. Any interpretive language, such as APL and FORTH, shares this virtue, but BASIC is really the only language that lends itself to change by program users who aren't also program developers. Another strong reason for choosing BASIC is to make programs as portable as possible among different brands of computer. In the past BASIC had the unique advantage of being the only universal language for

**B**ASIC  
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developers.

microcomputers; other languages, particularly C, are stepping into that arena more and more. Both of these reasons—ease of change and universality—explain why most programs for business accounting and applications are written in BASIC.

Speed can matter a great deal in some programs, although I think that the importance of program speed is often exaggerated; many accounting and game programs do very nicely with the relatively slow speed of interpreted BASIC. When speed matters—or might matter—a compiled language is important. If you are programming in BASIC, you would be very wise to make sure that your programs follow the slightly stricter rules necessary to be compiled; this gives you the option of freely trading between flexible interpreted BASIC and fast compiled BASIC. For the best program speed, C and compiled Pascal (but not p-System Pascal) are excellent, while FORTH and even compiled BASIC are mediocre. Sometimes one implemen-

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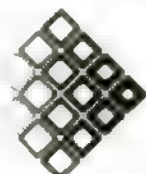
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tation of a language is much better than another; for example, reports have it that IBM/Microsoft's FORTRAN is pathetically slow while Supersoft's FORTRAN is said to be very fast.

**C IS A well-structured language, but it is also full of tricks, quirks, and quite a bit of cryptic notation.**

When the issues of program speed or program size are brought up, assembly language usually comes to mind. While assembly language allows ruthlessly tight programming (programming "down to the bare metal" with no overhead), the plain fact is that assembly language programming saves programming running time but squanders the scarcest resource of all, human programmer time. Except for limited special needs, such as the programs that are most intimate with the computer (like a BIOS control program), assembly language programming is an extravagant waste of human talent and should be avoided whenever possible. Most compiled languages are fast enough, but when the best speed or the closest intimacy with the computer is needed, then C stands out among high-level languages. For what is called "systems programming," meaning programs that must work closely with the computer (rather than from an arm's length relationship, which implies lots of programming language overhead), C is probably the best language available. Certainly C is widely accepted as such, and that acceptance ensures that its reputation will be fulfilled. As an example, a close look at the 2.0 version of DOS reveals some C programming language conventions that have been integrated into DOS. Things like this are best described in terms of "handwriting on the wall" and "a word to the wise," which lead system programmers like myself to migrate to C.

Experienced hands at computing know from painful experience that the cleaner and more comprehensible a program is,

the less likely that it will be bugged and the easier it will be to change and improve (as well as to debug). These reasons argue very very strongly in favor of programming languages that encourage and facilitate what is called "structured programming." The three best known structured languages are PL/I, Pascal, and C. PL/I is not widely available on personal computers, which largely rules it out for us. C is a well-structured language, but it is also full of tricks, quirks, and quite a bit of cryptic notation; from a structured programming point of view, this makes C much less desirable. On the other hand, Pascal has an unusually clean and clear form, and its heavy use of meaningful English words makes it easier to read and understand. In addition, Pascal includes features, such as enumerated data types and strong typing (which are ideas too complex to explain here), that greatly assist the writing of reliable programs. It is for these reasons that I consider Pascal to be, in general, the best programming language to use. If there is not some overriding reason to use another

language, I would say Pascal should be the first choice for all of us.

Neglected in this discussion so far are the two languages that dominate traditional large-scale computing, FORTRAN and COBOL. Both of these old languages were designed in the dark ages of computing and really should have been thrown out long ago. There is no need for personal computing to repeat the mistakes of traditional computing. The strongest argument for using either COBOL or FORTRAN is to transfer either existing programs or existing programming skills. While this might be legitimately very important to you, I would suggest that you ask yourself if it might also be shortsighted.

While your judgment and your opinions may not match mine, you should use this short discussion as a guide to developing your own rules for making a wise choice among programming languages. Working with a programming language is more like a marriage than like going on a date; you should choose with a long relationship in mind. /PC

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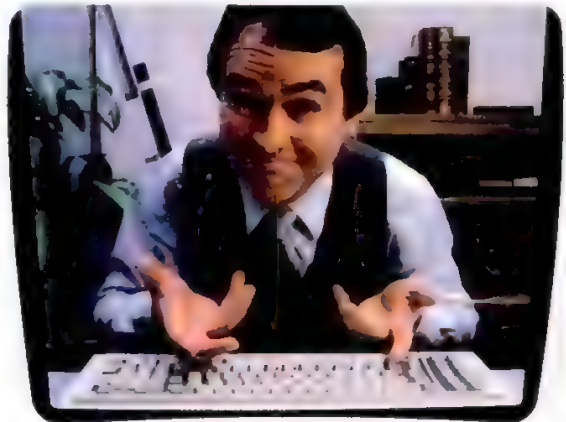
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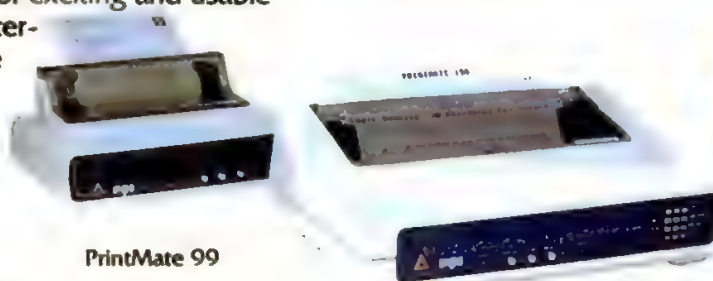
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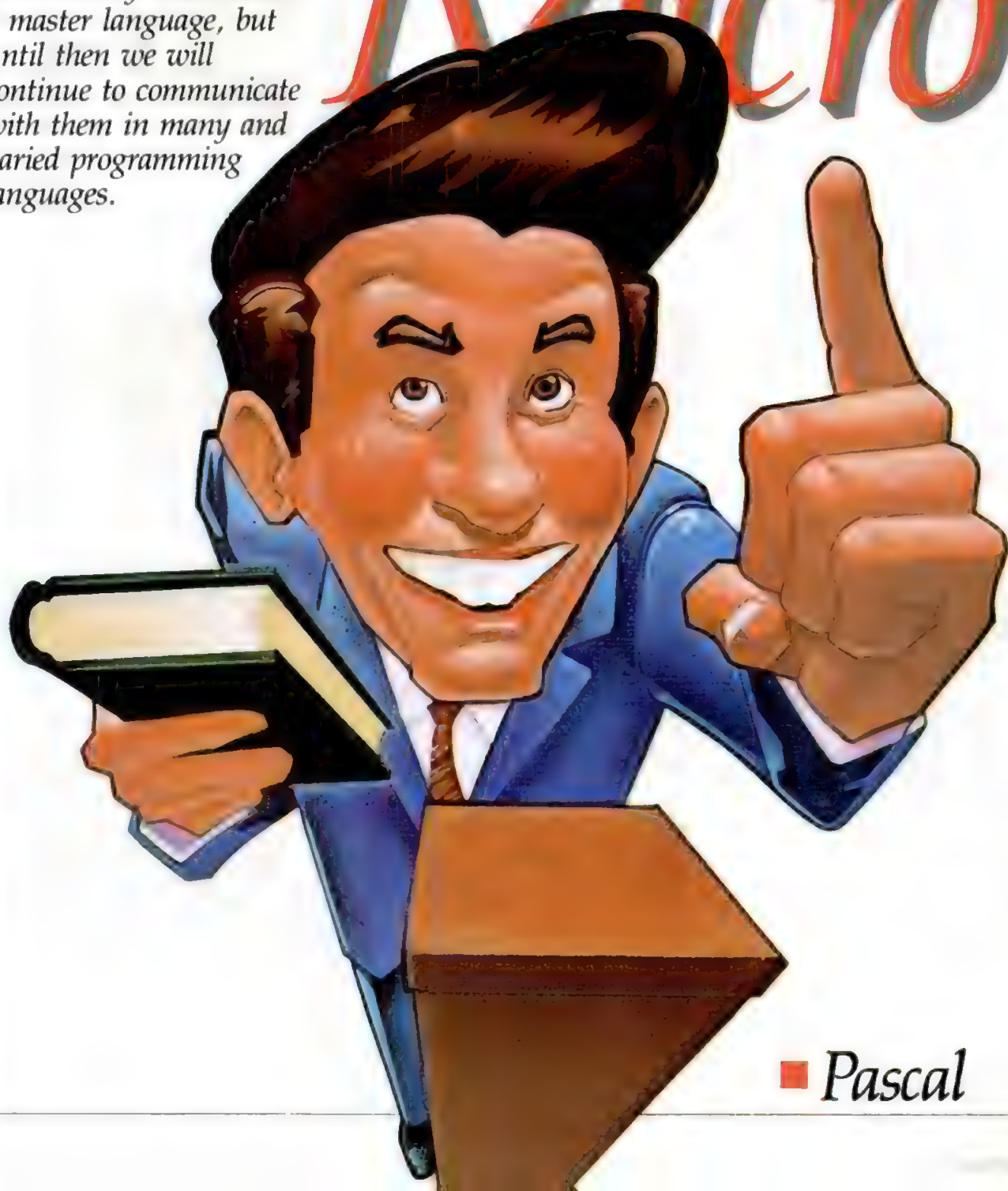
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LANGUAGES/  
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■ Perhaps computers will one day understand a master language, but until then we will continue to communicate with them in many and varied programming languages.

# Micro



■ Pascal



# Linguistics: Languages for the PC

**W**hat is a computer language? Are languages really necessary? Why can't we just talk to computers in English? Why can't there be one master language for talking to all computers? Computerphobes and crack programmers alike must deal with the vagaries of programming languages. Sociologists talk about the widening gulf between computer literates and illiterates. Computers are, they say, clearly dividing us into the haves and have nots. Are computers themselves

to blame? Of course not; the real culprit is the linguistic contortions necessary to communicate with computers.

Take two simple sentences: "Joe wants an orange. Give him one." The meaning is perfectly clear, even to a 2-year-old. A computer, however, is far too literal-minded to make any sense of it. Even if the computer knew what Joe and oranges were, it would have trouble figuring out to whom the "him" was referring. The meaning is further obscured by the ill-defined

"one." It begs the question, "One what?" As computers become more powerful and we become more skillful in programming them, they will eventually understand us when we speak to them like children. For the present, though, we are limited to formal computer languages.

The concept of a common language for all human interaction with computers is a dream to some, a nightmare to others. Each proponent of a common computer language proposes, of course, that his

native spoken language should be the basis for all programming. One of the goals of researchers currently working on "fifth-generation" computers is that the machines understand natural language. While some admit to the convenience of natural language, others want to retain the advantages of specific languages. The advantages may range from economy of expression, as in APL, FORTH, and C, to structuring techniques that reduce the chance for error, as in Pascal. It is unlikely that programming languages such as the ones we are covering here will disappear in the next 10 to 15 years, but some of them will fall into disuse. One of the things we'd like to show you is how the languages are comparatively better or worse at specific kinds of tasks. But first, a little background.

### Programming History

Programming was originally a process of connecting wires and throwing switches in order to connect the logical elements of the computer together in ways that would solve a particular problem or do some calculations. Early programmers were a curious blend of plumber, electrician, logician, and psychologist as they channeled signals around that would sort cards into the right bins or multiply two numbers. Bless the first person who realized that electronic patterns of ones and zeros could be substituted for actually throwing switches and connecting wires together.

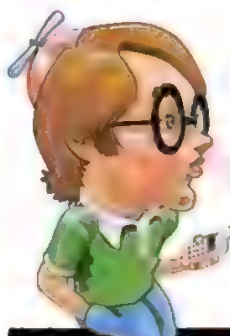
Ones and zeros made the programmer's lot simpler because he only had to code representations of the wires and switches. This was machine language coding. The next step was to use a number base other than binary to represent the settings. Decimal was too unwieldy, and octal (base 8) came into popular use. It was reasonably good at representing the word lengths of some of the early machines (would you believe 13 bits?). Then IBM invented the byte and settled on hexadecimal (base 16) as the best representation scheme. Octal still persists in much of the minicomputer world, despite the prevalence of hexadecimal in the mainframe and microcomputer industries.

The next big step in language design was to have the machine actually read

abbreviations for the operations that the hexadecimal codes were performing. This meant that every time you punched MUL or some such thing on a card, the assembler would generate the proper hexadecimal code for a multiply instruction. These were the first readable programs, and people could start thinking about structure.

Next came the macro assembler, one

## Basic



**B**LESS THE  
first person who realized  
that electronic patterns  
of ones and zeros could  
be substituted for  
actually throwing  
switches and connecting  
wires together.

that would permit a whole series of instructions to be assembled when a programmer-defined word or phrase was read. Variable names crept in to represent storage locations in memory and the contents of registers. Naturally, most of these words resembled English, and people started to get the idea that perhaps you could converse with the machine in a stilted English instead of loading registers and executing operation codes. Following the introduction of macro assemblers, it became necessary for programmers to agree upon and use standard libraries of macros.

Then someone decided that a program could analyze the standard words and variable names used by the programmer, read the standard libraries, and generate the necessary machine code. Thus, the compiler was born. Somewhere along the way, some bright fellows cooked up the notion of an operating system, a set of programs and services that programmers could use in a standard way. Operating systems permitted multi-tasking, allowing the computer to divide its resources among several jobs. Given the minuscule memory capacity of these early machines, it was important that programs avoid needless duplication of commonly used routines, such as input/output and disk access. This made the designing of compilers easier and greatly simplified the lives of programmers.

The only language that the central processing unit (CPU) really understands is machine code. This is a pattern of ones and zeros (high and low voltages) that causes the CPU to perform certain predefined tasks. One pattern, for instance, might instruct the CPU to "look" at a specific place inside the machine to see if a key was pressed. Another tells it to move a copy of the character typed into a register, a special kind of memory inside the CPU. A third moves the character from the CPU's register to a specific location in memory.

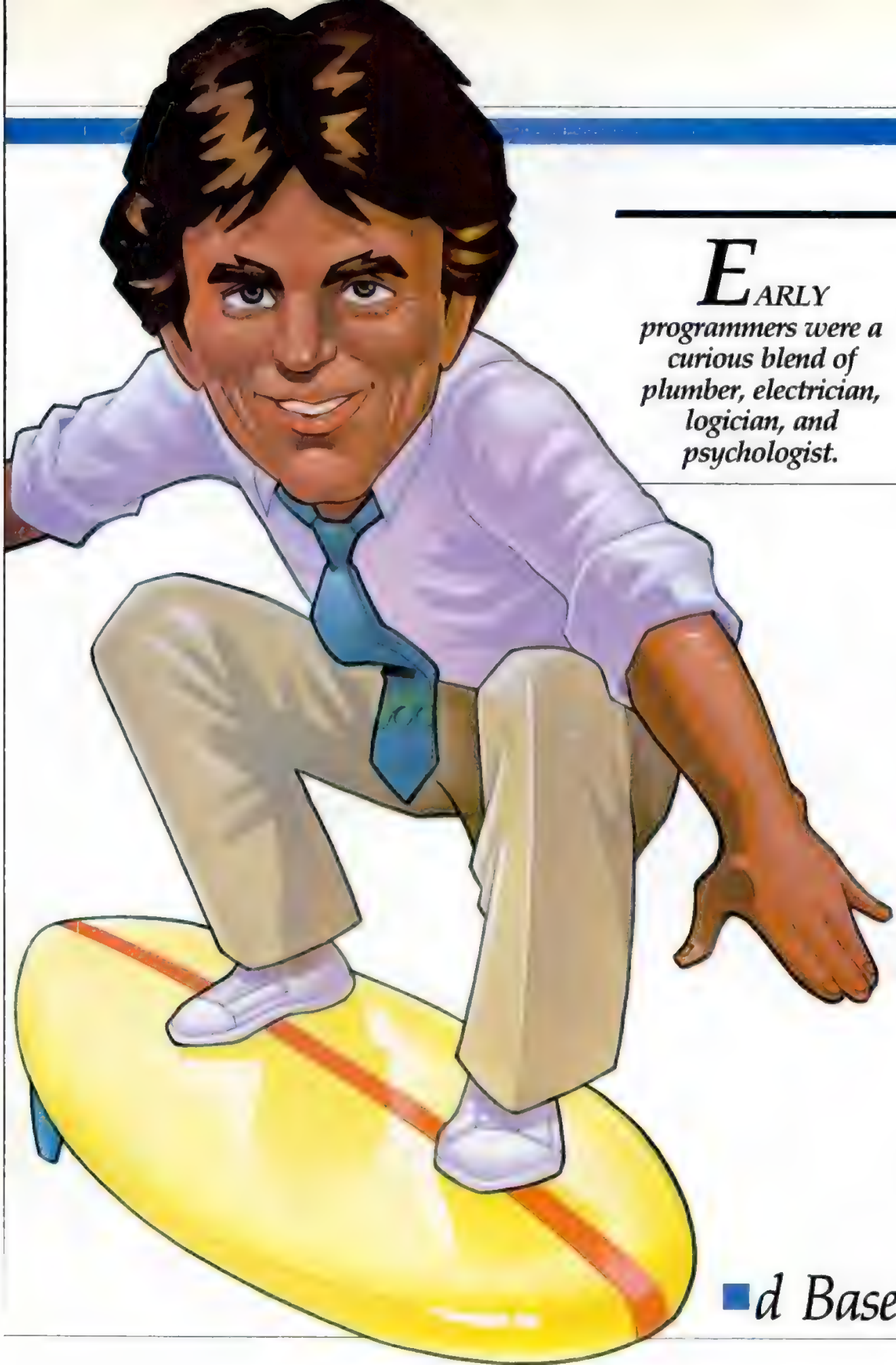
Instructions of this sort are used continually by word processing programs and many others. "Talking" to the machine on this level is exceedingly difficult, since the programmer must use exactly the right pattern for each action he wants the machine to perform. Assemblers make this particular job easier by figuring out the proper patterns for you. Short phrases, called mnemonics, tell the assembler what you want the CPU to do. For example, you might use phrases like:

```
MOV AX, (char)
MOV (loc), AX
```

As you can see, this isn't much of an improvement over ones and zeros.

Languages are customarily divided into high and low levels. Low-level languages tend to resemble assembly lan-





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**E**ARLY  
programmers were a  
curious blend of  
plumber, electrician,  
logician, and  
psychologist.

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■ *d Base II*



# ■ APL

## Focus on Functions

*Functions find the words that computer languages can't find for themselves.*

Functions are an integral part of modern computer languages. They help you extend the language in a powerful, useful, and controlled manner. The main purpose of a function is to describe something that the language cannot do in terms of things that it can do. Some languages are composed entirely of functions, most notably FORTH and APL. In APL, programs are called functions. In FORTH, they're called words. In either case, they become part of the working environment, available for use in defining new functions or words.

Contrast this to BASIC's function capability, which is actually a macro or shorthand phrase that allows you to tie together a number of standard BASIC syntax statements so that they are executed whenever you use the name of the function. You can pass values to the function by having dummy variables within the function definition. This is the only way that standard BASICs use local variables and a named rather than a numbered subroutine. While that's pretty good, there are still shortcomings. In other than sophisticated BASIC compiler implementations, you have to re-enter the functions into every program

you write; there is no way to incorporate them into the language.

Programs written in C are an agglomeration of functions as defined by the programmer and calls to standard functions. All of C's input/output, formatting, and string handling capabilities are defined in a standard function library. As such, they are part of the language, but you can add as many other functions as you like. Additions to the function library do not change the syntax of a C program, which enhances portability. C functions may be defined in terms of things that C already knows how to do or in assembly language calls to the operating system, or a mix of the two.

PL/I's functions are a bit different, allowing you to define named subroutines within the program or externally. The variables passed to the functions are local and have meaning only within the function. As with Pascal, PL/I allows you to define your own procedures and functions; indeed, the body of your program resides inside a master procedure called *main*. Lisp and LOGO provide for flexible function definition as well.

—B.M.

guages, or provide similar machine control capabilities, while high-level languages either resemble English or do many complex things in a few economical phrases. Some languages cloud the issue. Assemblers can have features normally associated with high-level languages and high-level languages can get "down and dirty" and interact with the CPU the way an assembler does.

### Definitions and Categories

Time for some definitions and some categorization. An assembler converts mnemonics, which represent operations that you want the CPU to perform into the machine instructions (ones and zeros), which actually do the work. An interpreter takes a program that you have written and scans it, line by line, converting your instructions into machine language as it goes. A compiler scans the program you have written and converts it into machine instructions for execution at some later time. There are some languages or implementations of languages that cloud the difference between interpreters and compilers. Terms such as *pseudo-compiler* and *incremental compiler* abound. You will hear some languages referred to as *strongly typed* or *structured*. Structured languages permit you to create procedures

## ■ Cobol





that have one specific entry point and one specific exit or return point. Variables used within a procedure are usually "local," meaning that they do not affect other values within the program, even if they have the same name. There is always some override provision for making variables global, or accessible from any part of the program. Contrast this to BASIC, which allows you to GOSUB to a specific subroutine and jump out of that subroutine any time you want, and go literally anywhere else in the program. Such shenanigans are not condoned by structured languages.

Data typing simply means that you have to tell the compiler the names of variables and what kind of data they will contain before you actually use the variable. Some languages allow you to predefine the startup value of a variable, while some also permit format statements, which describe how a variable will look when displayed or printed. Some languages are very loose in data typing, such as BASIC, which allows you to create variables on the fly, with no advance notice other than dimensioning arrays. Others, such as C, require that you specify the variables you are going to use, but allow considerable flexibility in moving data around from one type to another or mixing data types in calculations. Pascal and COBOL, on the other hand, are extremely rigid in the way they allow data types to be used, and are generally considered a good discipline for newcomers to programming.

Strong data typing means that if, for example, you define one value as an integer and another as a floating-point number, you can't even add them together. Pascal is strong on data typing to the point of obnoxiousness, while BASIC, at the other end of the spectrum, just makes some assumptions and does what you tell it to do. Other languages fall inbetween, with conversion rules and functions that permit mixing of data types. In the long run, it's probably okay for a language to disallow the mixing of data types, as long as it has convenient operators or functions for conversion of one type to another.

Structure has a different meaning when applied to data. Data structures are a logical outgrowth of data typing. You lump groups of data types together and give them a name, then you can manipu-

late all of them as a group (which may be called a "structure" or a "record"). Business data processing becomes infinitely easier, programs take less time to write,

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**B**ASIC  
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 language to be  
 implemented on a  
 microcomputer and has  
 been far and away the  
 most prevalent language  
 on micros ever since.*

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and the functionality and comprehensibility of a program increases dramatically.

#### ■ BASIC

BASIC is an acronym for Beginners' All-purpose Symbolic Instruction Code. The most common of all computer languages, it was developed in the early 1960s at Dartmouth College in New Hampshire by John Kemeny and Thomas Kurtz. Their objective was to make the

computer more accessible while retaining the mathematical and computational power of FORTRAN. The main thing that distinguished BASIC from other languages available at the time was that it was (and still is) an interpreter. This means each program line you write is converted to machine instructions as the program is executing. Contrast this to compilers, which convert your program to machine instructions all at once, and then allow you to execute the machine instructions. BASIC loses quite a bit in speed of execution, but this is usually offset by the convenience of being able to change a line or two and rerun the program immediately, without recompilation. You can also run small parts of a program to check the correctness of a section, or you can even run a single line of code. Professional programmers disdain these features, but then, it was not to them that BASIC was originally addressed.

BASIC was the first high-level language to be implemented on a microcomputer and has been far and away the most prevalent language used on micros ever since. A variety of vendors have created BASIC compilers. These programs allow you to prepare a program with an interpreter, testing it line by line, if you desire. When it works the way you want, you feed the source program to the compiler, which converts it to machine code. These compiled BASIC programs typically run

four to twenty times faster than their interpreted counterparts. A few pseudo-compiler versions of BASIC are around, but they are falling into



■ **Fortran**



disuse as they are replaced by true compilers. These pseudo-compilers simply convert BASIC's key words and variable names into coded abbreviations, called tokens. The tokenized program, called intermediate code, is interpreted by a special program called a run-time module. This is faster than a pure BASIC interpreter, but slower than a compiler.

BASIC's greatest strengths are the ease with which it can be learned, and its speed in getting something useful on the screen.

Beyond the fundamentals, BASIC has many extensions, called functions, which handle trigonometry, string manipulation, and other complex tasks. Most versions include a feature called *define function*, which permits astute programmers to create their own extensions. Its greatest and most criticized weakness is its utter lack of structure. Using the GOTO instruction, programmers can (and often do) leap around from line to line in a fashion that would confuse even the program's author. This is known as *spaghetti code*. Other languages, such as COBOL, are not immune to spaghetti coding, but BASIC almost invites it. BASIC is also a victim of the professional programmer's snobbery. Having worked long and hard at learning other languages, he can't believe that something so simple can produce commercially useful results. The time-honored answer to the professional's question, "What's it written in?" is inevitably, "Uhhh, BASIC, but it's an advanced version."

#### ■ COBOL

COBOL shares honors with BASIC as the most widely used language. It too is acronymic in name, COmmon Business Oriented Language. COBOL's chief progenitor was Captain Grace Hopper of the U.S. Navy. She and her team designed the first standard version of the language in the early 1960s. COBOL is well-suited to business applications because it is wordy, making it easy to write clearly understandable programs. Which is not to say that all COBOL programs are models of clarity; it is just as easy to write turgid code in COBOL as in any other language.

IBM is largely responsible for COBOL's

popularity in the business world today. Data processing managers sorely needed a consistent approach to designing, writing, and debugging the tremendous number of programs needed by businesses to break the paperwork bottleneck (and keep the big machine they bought from IBM busy). The folly of writing payroll packages and the like in assembler was clear: While a proficient programmer could crank one out in reasonable time, it was virtually impossible for anyone else to understand the program without lengthy study. Thus, maintenance and improvement of programs became a whole new corporate bottleneck. Legions of pin-striped, white-shirted salesmen viewed COBOL as a god-send, with code so readable that any manager could ostensibly pick up a program and discern its meaning. While it's true that COBOL takes nothing for granted, its drawback is obvious: You have to tell it everything within the program, including the make and model of the machine it is going to run on. COBOL is file-oriented, meaning that it has built-in commands that understand records, indexes, and the

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**S**INCE IT'S  
the oldest of the  
currently extant  
languages, some  
programmers enjoy  
poking fun at the old  
dinosaur.

---

like. If you are shopping for the ideal language, you can certainly do better.

#### ■ FORTRAN

FORTRAN derives its name from FORmula TRANslation, its scientific heritage obvious. Since it's the oldest of the currently extant languages, some programmers enjoy poking fun at the old dinosaur. It's really a cheap shot, though. Although we've learned that FORTRAN is a good example of how not to design a program-

ming language, its legacy is clear: It is BASIC's immediate parent. Many features, such as line numbers, functions, algebraic expression of arithmetic calculations, loop structures, and internal storage of data found their way into BASIC, with few changes.

FORTRAN's major design objectives were to permit scientists to write algebraic formulas in a form the machine could understand without mangling them, and to provide access to lots of storage for number crunching. Furthermore, it provided "massaging" of large numeric arrays. String handling and data structure were hardly considered at all. Some nonstandard features crept into versions of FORTRAN, hampering portability of programs and forcing the language back to the standards committees. In spite of this, many complex and useful programs were written in FORTRAN, mainly because it was the only game in town. Several popular mainframe database management systems owe their existence to FORTRAN. Back when it was the only decent compiler around for many machines, a group of computer scientists at Bell Labs cooked up Ratfor, which stands for Rational Fortran. It is a preprocessor that allows you to write neat, structured code, which is then translated into normal FORTRAN statements for the compiler. It overcomes many of the objections and problems of FORTRAN programming, but, because its use is mainly limited to universities, it is unlikely to cause a resurgence of interest in the language. Many FORTRAN programs are still in use today and many "Intro to Data Processing" courses teach it as an introductory language, an act that computer scientist Edsger Dijkstra calls a capital offense. The disfavor into which FORTRAN has fallen is not entirely undeserved.

#### ■ Pascal

Pascal was written as a teaching language by Nicklaus Wirth, a Swiss computer scientist. It addresses many of the problems faced by FORTRAN programmers and provides a highly structured way of writing programs. The parent language for all block-structured languages is Algol, a favorite in Europe, but little used in the





■ Logo

U.S., other than in some universities. One of its central ideas is that the more GOTOs there are in a program, the more prone it is to error. Therefore, there is no such thing as a GOTO in Pascal.

Fans of Pascal have elevated it to near religion, while vendors of compilers have extended the language in many ways

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**W**IRTH IS  
*both pleased and  
somewhat appalled by  
the widespread use and  
adaptation of Pascal.*

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Wirth never specified in order to make it usable in business. The main attraction of Pascal is its clean, block-structured approach. The major Pascal offering, UCSD Pascal, works by replacing each statement with tokens and internal symbols, called p-Code. All UCSD Pascal compilers generate the same p-Code, regardless of the processor. When SofTech, the originator of UCSD Pascal, wants to put Pascal on a new machine, all it does is write a new p-Code interpreter for that machine, with appropriate drivers for input, output, printers, and disks. Thus, Pascal programs can be moved easily to many different machines. Note, though, that it is an interpreter. Like pseudo-compiled BASICs, UCSD Pascal will always be somewhat slower than true compilers because the p-Code must be interpreted. This statement, like every other definitive one, contains a contradiction. Some manufacturers have built "Pascal Engines," computers designed to execute p-Code directly. IBM Pascal, made by Microsoft, is a true compiler and bears a family resemblance to Microsoft's FORTRAN, BASIC, and COBOL compilers.

Wirth, meanwhile, is both pleased and somewhat appalled by the widespread use and adaptation of Pascal. He has designed a new language, Modula-2, which incorporates Pascal's design features with sufficient power to handle business applications without add-ons. Perhaps Pascal



will return to its intended purpose: teaching people to think in a structured way. Modula-2, by the way, was designed to run on a computer called Lilith, which was designed solely to execute Modula-2 rapidly. This is not an insurmountable obstacle to compiler writers; a PC version of Modula-2 is currently in the works. Perhaps it should have been called Rational Pascal, or RATPAC.

#### ■ APL

APL, authored by Ken Iverson (then of IBM), is the most idiosyncratic of languages. APL stands for "A Programming Language," and this is just what it is. What makes APL outstandingly different from other languages is its unique character set—it uses Greek and some special over-strike characters—the brevity and power

of its operators, and, that it reads from right to left. Furthermore, it is an interpreter in a world in which everyone knows you need a compiler for speed. It was first designed for large mainframe machines, and still needs large quantities of memory if it is to do its thing properly. Programs are called functions in APL and are stored in memory, which is called the Workspace (WS).

APL achieved its place in the larger scheme of programming languages by being succinct; that is, expressing grandiose ideas in a line or two of code and by making it easy to build and manipulate large multidimensional numeric arrays. The language requires a special character set to work on the PC. This can be accomplished by plugging in a new ROM on the monochrome adapter board or by using

the graphics capabilities of the color board. Of all the languages available for the PC, APL is probably the one that benefits most from using the 8087 coprocessor's mathematical power.

APL is going in two directions at once in terms of user acceptance and availability. While it has disappeared from IBM's earlier 5100 series of desktop computers and from many time-sharing services, it is enjoying a renaissance on the PC. At one time, APL was the only language available that would permit certain kinds of calculations, such as linear programming models. Now, however, C, PL/I, and Pascal all provide equivalent number-crunching power. APL still remains attractive, though, because it is an interpreter and because it is so elegant. While other languages may actually crunch the numbers

## Portability: Which Languages Get Around—And Why

*Are any of the available programming languages truly portable?*

Portability is the ability to move a program from one machine to a completely different make and model and have it run successfully. It has long been a dream of systems developers everywhere. What makes a program portable? Is there, in fact, any such thing as portability? Yes and no.

FORTRAN was supposed to be portable. It turned out to be one of the least portable environments for programs. What went wrong? The main problem within FORTRAN is that it matters a great deal how the language stores things internally. Thus, a program that did a calculation properly on one machine would either make mistakes on another machine or not work at all, mind you, with an ostensibly identical version of the FORTRAN compiler. The solution was usually to rewrite the program, a time-consuming and expensive proposition.

The other problem was nonstandard implementations. Systems programmers (precursors of today's hackers) delighted in "improving" the compiler and added

many nonstandard front-end and back-end features. Some of them were quite good and gained wide acceptance, while others were just obstacles. Then you had to know whether you were using FORTRAN IV, FORTRAN V or WATFIV (Waterloo University's version of FORTRAN V), or whatever.

The situation was no better with COBOL. Everyone liked the idea of COBOL, but no one could agree on a total definition for the language, let alone details of how things should work. Each computer manufacturer produced its own version of COBOL, supposedly better than everyone else's, but necessarily incompatible. Fortunately, the Navy was making a big investment in computers and programs and wanted to use COBOL.

The Navy's computer brass knew what was going on in the industry and wanted no part of it. They formed a standards committee under the aegis of the American National Standards Institute (ANSI) to create a standard for future versions of

COBOL. Grace Hopper headed the committee and ANSI COBOL was born. Still, vagaries of machine word length, I/O conventions, control language, and implementation limit the degree to which COBOL programs can be moved around. Portability (in the mainframe world) tends to be excellent among similar machines from the same manufacturer, but falls to pieces rapidly as you branch out to other manufacturers. In the micro environment, the common denominator tends to be the compiler vendor rather than the hardware. So programs written under RM COBOL tend to run on any machine for which Ryan-Macfarland, a manufacturer of COBOL compilers, has implemented a version of its compiler.

One reason that there is so much prejudice against BASIC is that there are so many versions. Even from a major vendor like Microsoft, the implementation for each machine can vary widely. Other vendors (yes, there are others) introduce still more variants. Translation from one dia-



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## **A**PL REMAINS *attractive because it is an interpreter and because it is so elegant.*

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faster, it is much easier to change an operator or an assumption in an APL program and get the answers without the lengthy compile and link steps usually required by the compilers.

### ■ PL/I

PL/I (that's a Roman numeral one) is IBM's answer to the Swiss Army knife.

Intended to be all things to all people, it ended up being one of the biggest, most complex languages ever written. It is wordy like COBOL, crunches numbers like FORTRAN, has block structure like Algol, and some syntax that isn't too far removed from BASIC. Some of the folks at IBM wanted to call it FORTRAN VI. The result, however, is impossibly unwieldy: PL/I has at least three ways to do anything. The language's many virtues were obscured by its complexity. IBM pushed very hard to make it the *de facto* mainframe language, but was unable to unseat COBOL. PL/I received somewhat more acceptance from the scientific community, because many people were ready for something better than FORTRAN. The good parts of PL/I spawned several imitators, special-purpose adaptations, and subsets, including

PL/M, the systems programming language Gary Kildall wrote for Intel. Other systems programming languages, such as Hewlett-Packard's SPL, bear a strong resemblance. PL/I was saved from ignominy by a standards committee, which sought to whittle it down to a manageable size for minicomputers. The committee excised many of the abstruse and redundant features of the language, and created PL/I Subset G (for

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## **P**L/I HAS *at least three ways to do anything.*

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lect of BASIC to another, especially if file, cursor control, or string operations are involved, can be nearly impossible.

Pascal, given its heritage as a teaching language unencumbered by all the functions needed for business use, has suffered the worst in its transition to an applications language. No two versions are the same. There is an ISO standard Pascal without any extensions that no one uses for business simply because it has no extensions.

APL is another language plagued by the vagaries of machine-dependent implementation. APL functions, as stored in the workspace, are not transportable. Any implementation that calls on hardware facilities (like a floating-point processor) specific to the installation will not transport well. APL will, however, transport at the source code or canonical representation level. Since most functions are fairly short, reentering them into a new system is not much of an obstacle.

The C language has fared better than

virtually any other language in terms of transportability of application programs. The machine-dependent capabilities of C tend to be used only for systems programming. C's single-source history and the fact that the UNIX operating system is written in C are the two major factors. In order to put UNIX on a new machine, you need to have implemented a fully functional C compiler.

C compilers for non-UNIX systems tend to follow the standard C very closely. There are a few subsets of the language for 8-bit machines, but most of the 16-bit and many of the 8-bit versions are complete. There is no need to extend C because of its ability to handle functions (see sidebar on Functions).

Other than the usual storage boundary (machine word length) problems, PL/I programs tend to be fairly portable. Granted, there are some variants, most significantly PL/C, Cornell University's version. Minicomputer and microcomputer versions follow the Subset G version and

have a high degree of portability.

The military has been one of the strongest influences on standards in computer systems and languages. The work done on COBOL is the best example, but the brass realized they needed a more modern, structured language similar to PL/I, Pascal, or C. There have been other standard military languages, such as the Air Force's Jovial. Lack of acceptance, poor training, and shortcomings in the language prevented it from becoming a standard. The decision was made to go for an all-new language, designed from the ground up for weapons control systems. This, of course, is Ada. Ada most closely resembles Pascal, with some significant improvements and extensive enhancements. It is big, like the original PL/I and will, its designers hope, be all that the government wants it to be. It is illegal for anyone to produce a subset or otherwise modified version of Ada and still refer to it as Ada. This is one compiler that will provide (if all goes well) full portability. —B.M.





■ PL/I



general purpose). It succeeded, and Digital Research built a Subset G compiler that would run on the 8080. It was only a matter of time before it was translated to 8086 code, giving us a version that could run on the PC.

### ■ The C Language

The programming language C has probably captured the imagination of more people than any other modern language. It is relatively unique in having been created as Bell Labs's in-house system development language, then exported to the world through Bell's UNIX operating system. Just before C was developed, another language, called B (after Bell Labs), had been developed in-house. The B language never saw the light of day, but C's authors, Brian Kernighan and Dennis Ritchie, named their new language C for the simple reason that it followed B. In developing C, Kernighan and Ritchie looked at virtually all the programming languages available at

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for systems programming—the writing of operating systems, compilers, word processors, and other utility programs. Virtually every machine has a full implementation of C available for it, which means that programs can be transported to new com-

puters with relative ease, that they will run fast, and that they will be relatively small, compared to most other compilers. Portability is aided by C's single-source beginnings; there are few nonstandard versions around. Most of the "nonstandardness" that you find in C shows up in the names given to functions rather than in alterations to the syntax.

C's most distinguishing feature is that it is made up almost entirely of functions. That is, each predefined statement is stored in a library and only becomes part of your program if you use it. You can define new functions, either in C or in assembly language, and incorporate them into the function library. With all the noise currently being made about reusable code in business and professional circles, one wonders if they've looked at C. The

**C** HAS  
become the language of  
choice for systems  
programming.

the time, took the features that they liked, and created a language that produces tight, fast code. It is part of the overall implementation of the Programmer's Workbench, a collection of software tools designed to make it easy to create and maintain programs by project teams.

C is block structured, and is similar in syntax to PL/I. It is, however, much more economical in some of its expressions, especially logical operators. Some people criticize C because it can be too cryptic. It is also known as a high-level, low-level language, because it is fairly easy to manipulate bits and bytes, allowing you to do things that would otherwise require a separate assemble-and-link step, or that couldn't be done at all in some languages.

C has become the language of choice





network of users who share C routines, especially in the UNIX world, is enormous, far larger than the PC bulletin board and software network. C is also designed to use the power of the operating system to the greatest possible extent. All of these factors explain why the machine language modules produced by C are so compact.

## ■ dBase II

What's a commercial product like dBase II command language doing in a language comparison article? Holding its own. So many people use dBase II on PCs and other micros that it has attained a kind of *de facto* acceptance as a language. Its major attraction is that it uses the built-in

## ■ Assembler



**T**HE NETWORK of users who share C routines, especially in the UNIX world, is enormous.

database management system, making file-oriented operations a cinch. Syntactically, it is somewhere between BASIC and Pascal, though leaning more toward the latter. For example, there is no GOTO phrase in the language. It is procedural and block-structured, making it easy to read and follow if you don't get too deeply mired in nested IFs.

dBase II and its command language are the microcomputer descendants of an in-house database management system at the Jet Propulsion Lab (JPL). Some of the idiosyncrasies of dBase II reflect its single-author (Wayne Ratliff) origin. It inherited a number of limitations from its 8-bit, 64K machine origins. A version that would take full advantage of 16-bit processors would be most welcome. Meanwhile, dBase II commercial applications, including entire accounting systems, are proliferating.

The command language is an interpreter, which is somewhat unique in that it does not require line numbers. This has a negative impact on overall speed, since there is no GOTO or PERFORM statement. DO doesn't count, since it goes out to disk and gets a new program. The interpreter, therefore, must slog through line after line of code, looking for ENDIFs and ELSEs to determine what to do next. One of the conveniences of the dBase II system is the built-in program editor. The best way to describe it is "line-at-a-time WordStar." It uses the same control keys as WordStar for moving the cursor and inserting/deleting characters, but only one line at a time. It's too slow and unwieldy for major editing jobs, but handy for fixing an errant line of code without leaving dBase II. Another advantage results for dBase II's interpretive operation: interactive debugging. There are provisions for stepping through programs one line at a time and for using the printer as a documentation device.

## ■ FORTH

FORTH is another modern language, this one created by the astronomer Charles Moore to control telescopes. It is utterly unlike any of the other languages in this review, either in structure and programming style. FORTH is made up of a small kernel of words, each word performing a specific function like adding two numbers, or fetching something from a file. New words may be defined by stringing old ones together in whatever way you want. The new words have pointers that direct the computer to the locations of the old words. Since the kernel words are written in assembly language, the new words take up little space (they're just an index to the old words) and the whole

thing is very fast. The way new words are built on and linked to old words is called *threading*, and is the real key to FORTH's compactness and speed. The syntax is dramatically different from other languages,

**F**ORTH IS utterly unlike any of the other languages in this review, either in structure and programming style.

since it uses reverse Polish operations, as well as a "stack" to store variables, current results, and other partial results of operations. FORTH is well-suited to development of custom microprocessor-controlled hardware, like Moore's original telescope controllers. It is not particularly disposed to general purpose computing, although there are numerous devotees (acolytes?) who beg to differ. FORTH users are usually quietly satisfied with their discovery of the perfect language, while Pascal's minions are fervently evangelical, even violent in defense of their chosen language.

FORTH includes its own program editor and usually its own operating system. Programs are entered and stored in "screens," usually 256-byte chunks of program. A few FORTH implementations use the operating system for input and output (screen, disk, and printers), while others completely replace the operating system with FORTH's own.

Some assembly language programmers say they can do everything FORTH can do by using macros. They're missing the point. You've got to really understand the innards of the machine to write good macro code and the results are not (usually) threaded. With FORTH, you learn to think

■ Forth





like a hypothetical stack machine instead of thinking like the particular microprocessor you happen to be working on. Using assembly language to build applications programs is analogous to excavating a basement with a teaspoon. It'll do the job, but its arduous and few will want to trace your actions when it comes

time to modify or correct the program.

#### ■ LOGO

LOGO is one of the newest languages to arrive on the scene, an outgrowth of learning research and the way children interact with computers. One of the most outstanding features is the way it allows you to interact with the computer via the screen.

There is a special kind of cursor called a turtle. Imagine a mechanical turtle that can crawl around on a sheet of paper. It has a retractable pen in its belly. This is the essence of LOGO's turtle, except that its domain is the screen and it writes with light instead of ink. Children have found this imagery wonderfully attractive and the language makes it easy to move the turtle around. What, you may ask, is the significance of a children's language? Well, if that were all that LOGO were, it would still be important, because teaching young people to use computers effectively and to think clearly about solving problems with them is one of the largest challenges we face. LOGO has already demonstrated its prowess in this area.

Furthermore, LOGO is not limited to turtle graphics and education. It is just as

---

**L**OGO IS  
*just as capable as any  
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business graphics and  
other applications.*

---

capable as any other language for problem solving, business graphics, and other applications. Digital Research's forthcoming version of the language is a case in point. First, LOGO is an interpretive language, based on Lisp, the darling of the artificial intelligence community. The syntax and operators that resemble Lisp provide powerful string manipulation, as well as all the usual arithmetic functions. The result is a full-capability language with integrated record handling, screen management, and graphics. The possibilities for analyzing and acting upon English-like commands or responses entered by the user are far greater than anything else available at the moment.

/PC





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■ Six benchmark programs are presented in eleven languages allowing for broad comparisons among the languages.

# Benchmark Programs

**H**ow do you go about comparing languages? Some of our descriptions may have given you an inkling as to the particular strengths and weaknesses of certain languages. In addition to descriptions, benchmark programs can be helpful in evaluating languages. A benchmark is a routine, which in this case is written in each of the different languages, to perform a standard task. Here we present six simple routines in ten different languages. Each shows different dimensions of the language and uncovers some strengths and surprising weaknesses. Broad comparisons can then be made among the languages. One thing that benchmarks do not do especially well is tell you what the "fastest" language is. Labeling a language "fastest" based on a series of benchmarks is akin to the blind men describing the elephant.

Our main reason for presenting these benchmarks is to illustrate ways in which a language's capabilities may mesh with your needs. There is also a certain undefinable way in which a language meshes with your personality. Some people strongly prefer the structure of the COBOL environment, while others feel con-

strained by it. APL users claim that that language changes the way they think about problem-solving in general. The convenience of interpreters is priceless to some, worthless to others. A final consideration is the environment for which you're writing programs. Do you want the code to be transportable? To what kind of machines? Will the program be modified in the future by someone other than yourself? Does it have to be fast? Blazingly fast? Are you going to be the only user? Is there a prevailing standard language in the industry toward which your program is targeted? The ways in which the benchmarks are written in our sampler of languages and the performance of each one may help you decide. For our benchmark tests we have selected versions of the languages that are representative of what's available. In no way have we attempted to test every available version of every language. (See the Product Information sidebar for a more complete list of vendors of these languages.)

Once you have selected a new language, give it every chance to prove itself. If you are already proficient in BASIC, you may be overwhelmed by the seeming com-



plexity of PL/I or the abstractions of APL. You may, on the other hand, take immediately to the structures of C or Pascal. In most cases, you will have to do more to write a program than you are doing in BASIC, the exceptions being APL and FORTH. So, buy a book; buy two books. Take a course. But learn your new language. Give it a chance to show its stuff.

### Actual Benchmarks

Our first benchmark is simply an empty loop. We're asking the machine to do nothing 10,000 times. This gives us a handle on the flat-out looping—or iteration—speed of the language. Since asking any language to do something just once is like asking to see the fastest draw in the West (Wanna see it again?), we must ask it to repeat a task many times in order to find out how long it takes for one pass through. For example, BASICA takes 5 seconds to do the empty loop test, while COBOL takes 3.3 seconds for the same test.

The second test, integer addition, adds one to a variable until it equals 32,767, the limit for a 2-byte signed integer. Integer addition, like looping, is important in gauging a language's performance in time-critical operations.

The third benchmark, floating-point arithmetic, takes the mathematics out of the CPU and into memory, since double-precision or floating-point numbers are too large to fit into the 8088's registers. This routine gives you a handle on the relative efficiency of the floating-point calculation routines built into the language, an important consideration if you are doing lots of mixed or repetitive calculations.

String concatenation is our fourth test. In it, we assign strings to two variables, then combine the two variables into a third. Languages vary widely in their ability to handle strings and, while this test is far from inclusive (finding substrings within strings is another important feature), it is indicative of overall string-handling

Figure 1: An empty loop, expressed in BASIC.

```
1 'Empty loop in BASIC
5 DEFINT X
7 TIME$ = "0"
10 FOR X = 1 TO 10000
20 NEXT
30 PRINT TIME$
```

Figure 2: A FOR-NEXT loop.

```
1 'Integer count in BASIC
3 DEFINT X
5 TIME$ = "0"
10 WHILE X < 32767
20 X = X + 1
30 WEND
40 PRINT TIME$
```

Figure 3: DEF instructions for the BASIC interpreter.

```
1 'Floating point
5 DEFINT X
7 TIME$ = "0"
10 FOR X = 1 TO 10000
20 A=0:B=1234.56:C=78.9
30 A=B*C
40 A=B/C
50 NEXT
60 PRINT TIME$
```

Figure 4: To slow the program down strings are assigned within the loop.

```
1 'String concatenation test.
5 DEFINT X
7 TIME$ = "0"
10 FOR X = 1 TO 10000
20 A$ = "This is a string"
30 B$ = "This is a longer string with lots of words in it."
40 C$ = A$+B$
50 NEXT
60 PRINT TIME$
```

Figure 5: Table lookup in BASIC.

```
1 Table lookup test.
3 DEFINT B-Z
5 DIM A(25)
8 TIME$ = "0"
10 FOR X = 1 TO 1000
15     RESTORE 200
20     FOR LOOP = 1 TO 25
30         READ A(LOOP)
40     NEXT LOOP
50 NEXT
60 PRINT TIME$
70 END
200 DATA 1,2,3,4,5
210 DATA 6,7,8,9,10
220 DATA 11,12,13,14,15
230 DATA 16,17,18,19,20
240 DATA 21,22,23,24,25
```

Figure 6: This benchmark demonstrates BASIC's ease in handling records.

```
1 'File access test.
3 DEFINT X
5 TIME$ = "0"
10 OPEN "R",1,"TEST.DAT",132
20 FIELD #1, 132 AS RECORD$
30 FOR X = 1 TO 100
40     PUT #1,X
50 NEXT X
60 'read records back.
70 FOR X = 1 TO 100
80     GET #1,X
90 NEXT X
100 'modify and rewrite records.
110 FOR X = 1 TO 100
120     GOSUB 200
130     LSET RECORD$ = "Modified"
140     GOSUB 300
150 NEXT X
160 PRINT TIME$
170 END
180 '
200 GET #1,X
210 RETURN
300 PUT #1,X
310 RETURN
```

Figure 7: In LOGO, the string concatenation test.

```
TO STRING.CONCATENATION
MAKE "A [THIS IS A STRING]
MAKE "B [THIS IS A STRING WITH LOTS OF WORDS IN IT.]
MAKE "C SENTENCE :A :B
END

TO STRING.CONCATENATION.TFST
REPEAT 10000 [STRING.CONCATENATION]
END
```

dling speed.

The fifth test produces the greatest variation when translated to other languages. This is because languages vary drastically in the way in which they store data in tabular form internally. In the case of BASIC, DATA statements are accepted uncritically by the program. If there were an error, such as an alphabetic character among the numbers or a misplaced comma, it would not be detected until you ran the program. In a strongly typed language like Pascal, however, the compiler would check that each entry matched the declared data type during the compilation process. It is nearly impossible to get bad data into languages that are strongly typed.

The final test is the only one that goes "outside" memory to the disk. It gives some indication of the ease of handling files and the relative efficiency of the interaction with MS-DOS. We selected a file length of 132 because it might represent the width of lines to be printed in a real application, and because it does not agree with the sector size or any even fraction thereof of the operating system. Overall, we were pleasantly surprised at the

---

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language is.

---

speed with which the languages handled disk I/O. Note that PC LOGO does not handle file-oriented functions at this time, so it did not participate in this test.

Not having experience in all the languages that are being tested, we farmed out the actual coding chores on some of the languages from our BASIC prototypes. Each of the persons or companies is an expert in the language we assigned. Their comments are included in the body of this article and in various notes within the tables and sidebars.



## BASIC

Here is our empty loop in BASIC (see Figure 1). Note that we do not use the variable name in the NEXT statement to maximize speed.

Counting to 32,767 can be done either of two ways, with a WHILE loop or a FOR-NEXT loop. FOR-NEXT is many times faster (see Figure 2).

Floating-point operations are assumed by the BASIC interpreter unless instructed otherwise by a DEF instruction (see Figure 3).

Notice that we are assigning the strings within the loop (see Figure 4). This slows the program down, but this is all right for a benchmark.

An interesting finding in this benchmark is that BASIC converts the representations in the DATA statements (which are stored as you typed them) to single-precision numbers faster than it can convert them to integers (see Figure 5).

BASIC's ease in handling odd-sized records is evident in this benchmark (see Figure 6). It has an advantage over languages that only provide sequential access to files or that require files to be closed or "rewound" before they can be reaccessed.

## LOGO

Bill Glass, of Harvard Associates, provided our LOGO routines. Written by Gold Hill Computers, Inc., of Lincoln, Massachusetts, PC LOGO is a product of Harvard Associates. Bill comments: "LOGO is very different from other languages, since it provides an integrated programming environment (combined program editor and runtime support). This frees users from having to control storage allocation, but intermittent garbage collection (reuse of memory) can potentially extend computation times."

The technique used for implementing the string concatenation test is similar to that used in the floating point test (see Figure 7).

Figure 8: In LOGO, the internal data lookup test.

```
TO INTERNAL.DATA.LOOKUP
MAKE "DATA [1 2 3 4 5 6 7 8 9 10 11 12 13
            14 15 16 17 18 19 20 21 22 23 24 25]
MAKE "A "
REPEAT 25 MAKE "A SENTENCE :A FIRST :DATA MAKE "DATA BUTFIRST :DATA
END

TO INTERNAL.DATA.LOOKUP.TEST
REPEAT 1000 [INTERNAL.DATA.LOOKUP]
END
```

Figure 9: In COBOL, the working storage section for the string concatenation program.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. STRING.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. VICTOR 9000
OBJECT-COMPUTER. IBM-PC.
DATA DIVISION.
WORKING-STORAGE SECTION.
77 A PIC X(16) VALUE "This is a string".
77 B PIC X(48) VALUE
    "This is a longer string with lots of words in it".
77 C PIC X(64).
PROCEDURE DIVISION.
000-MAIN.
    PERFORM CONCATENATE-STRING 10000 TIMES.
    STOP RUN.
CONCATENATE-STRING.
    STRING A B DELIMITED BY SIZE INTO C.
```

Figure 10: COBOL's read/write/modify program.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. FILEHN.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. VICTOR 9000
OBJECT-COMPUTER. IBM-PC.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT TEST-DATA-FILE ASSIGN TO DISK
    ACCESS MODE IS SEQUENTIAL.

DATA DIVISION.
FILE SECTION.
FD TEST-DATA-FILE
    LABEL RECORDS ARE STANDARD
    VALUE OF FILE-ID IS "TEST.DAT".
01 TEST-RECORD PIC X(132).

WORKING-STORAGE SECTION.
77 DOLLAR-RECORD PIC X(132) VALUE ALL 'S'.
01 SWITCHES.
    03 E-O-J-SWITCH PIC X VALUE 'N'.
    88 E-O-J VALUE 'Y'.
PROCEDURE DIVISION.
000-MAIN.
    OPEN OUTPUT TEST-DATA-FILE.
    PERFORM WRITE-NEW-RECORD 100 TIMES.
    CLOSE TEST-DATA-FILE.
    OPEN I-O TEST-DATA-FILE.
    PERFORM REWRITE-OLD-RECORD UNTIL E-O-J.
    CLOSE TEST-DATA-FILE.
    STOP RUN.
WRITE-NEW-RECORD.
    WRITE TEST-RECORD.
REWRITE-OLD-RECORD.
    READ TEST-DATA-FILE
        AT END MOVE 'Y' TO E-O-J-SWITCH.
    IF NOT E-O-J
        REWRITE TEST-RECORD.
```

LOGO begins to show its unique talents in the internal data lookup test. The words FIRST and BUTFIRST are used to select the first element from the array and

***D***ON'T USE  
COBOL if your  
application is primarily  
personal or if you know  
that it will not be used 2  
years hence.

then eliminate the first element from the remainder of the array (see Figure 8).

#### ■ COBOL

Mark Wisan, president of V.P. Communications, Inc. has been working with COBOL since 1973 as a programmer, systems analyst, and consultant. Most of his experience has been with IBM 360/370 COBOL and IMS database applications. V.P. Communications, Inc. provides sales and support of business and personal computers and offers custom programming in dBase II, COBOL, and BASIC for Victor 9000s, IBM PCs, and PC compatibles.

Wisan reports that IBM PC COBOL (Microsoft COBOL) is very similar to the versions that run on very large IBM systems, as well as on mainframes from other manufacturers. In addition, the Microsoft COBOL source code runs with only minor changes on 8-bit CP/M systems, and most computers that support MS-DOS.

Wisan comments, "Don't use COBOL if your application is primarily personal or if you know that it will not be used 2 years hence. Don't use COBOL unless you are willing to write for future programmers who may have to modify your code when you are no longer available to advise them. Don't use COBOL unless you are willing to take the time to carefully design your application and get it going in a modular "top-down" structured fashion."

V.P. Communications, Inc. is located

## Assembly Language

*In most assembly language programs, well over half the characters are comments, which are helpful in understanding the program's logic.*

Writing in assembly is the way to wring the maximum utility out of your machine. If it can't be done in assembly, it can't be done at all. If code must run as fast as possible, or must be compressed into the smallest possible amount of memory (note that these two are not necessarily compatible objectives), assembly language is the language to use.

In a good assembly language program, well over half the characters in each source file are comments rather than code. For trivial programs such as the string concatenation program, the comments are not absolutely necessary, but are included just to give the reader a sense of what is going on.

In other programs—internal data table lookup, record create, read, update—the comments are essential. They serve to remind you of what you are doing as you write, and they make it possible to modify or correct the program without having to completely re-analyze the logic every time.

Anyone who has tried to figure out how a program works by looking at the uncommented code produced by the U (unassemble) command in the PC's Debug utility will immediately appreciate the value of comments. Even the sparse ones are helpful for understanding program logic.

In assembly, there is no pretense that the code in itself is "selfdocumenting." The microprocessor is designed for computing power, speed, and efficiency first; ease of programming is, at best, a secondary design consideration.

Historically, Intel has not been known for producing machines that are easy to program in assembly. The 8088/8086 family is no exception. These microprocessors are filled with little quirks and special situations that allow the programmer to squeeze every possible bit of computational speed out of the technology.

As a consequence, learning to program the 8088 in assembly language requires

rote memorization of miscellaneous special features. For example, the 8088/8086 family all have eight 16-bit general-purpose registers, denoted AX, BX, CX, DX, SI, DI, BP, and SP. They are general purpose in that each register can be used for addition, subtraction, logical operations, and shifts, but each register also has one or more special purposes:

- AX must contain one of the factors when multiplying.

- BX has a special role in translating character codes.

- CX must be used with looping and repetition instructions.

- DX must be used to hold I/O addresses greater than 255.

- SI points to the source characters in a string move.

- DI points to the destination in a string move.

- BP as an address pointer points into the stack by default.

- SP has stack maintenance as its primary function.

***T***HE  
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The above list is not complete. There are additional special purposes for each "general-purpose" register, and the programmer must be familiar with all of them in order to write efficient 8088/8086 code.



Since each register has been assigned special functions that it alone can perform, values may not always be in the par-

---

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---

ticular register where they are needed. The contents of any register need to be shuffled around, which is one of the things that makes the code of the floating-point operations program somewhat convoluted. Part of the program has no purpose other than to move a partial result out of the way or into a register with a particular special purpose.

Although it is possible to write assembly language programs from scratch, anyone who does a significant amount of assembly language programming builds up a library of subroutines and pieces of code that can be used as building blocks. The IBM PC Macro Assembler facilitates the use of such building blocks by providing an "include" instruction and a "macro" processor. The "include" instruction tells the assembler to include in the assembly the contents of the file named in the "include" instruction. In an assembly listing, lines of code brought into the listing via an "include" instruction are prefixed with a letter "C."

Thus, in the record create, read, update program, the instruction "include doscall.asm" tells the assembler to include at

that point all of the code in the file named doscall.asm. I created this file so that I would not have to remember the function number for each of the 30 or so DOS functions. It assigns mnemonic names to them so I can refer to them by name in the main program.

The "macro" processor built into the assembler is another productivity tool for writing assembly language code. It allows you to define, for the duration of an assembly, new instruction codes that stand for several or many lines of code that may be repeated in the body of a program. The included file, "doscall.asm," in the record create, read, update program contains the definition of a macro named "doscall," which stands for the code necessary to invoke a DOS function. In an assembly listing, lines of source code created by the macro processor are prefixed by a plus sign (+).

In addition to the use of the include and macro facilities of the IBM Personal Computer Macro Assembler, the record create, read, update program and the floating-point operations program were written with the assistance of a structured assembly preprocessor, which enables the programmer to use structured programming constructs such as if-else-endif, repeat-until, and while-endwhile. The preprocessor converts these constructs into the appropriate assembly code, relieving the programmer of just a little bit of the burden of assembler language programming.

These structured assembly pseudo-instructions show up as comment lines beginning with xif, xifcond, xelse, xendif, xrepeat, xuntil, xwhile, and xendwh. The code generated from them by the preprocessor follows them, but other than the fact that the generated code lines do not contain comments and the fact that labels generated by the preprocessor all have the form x9999x: (where 9999 is a 4-digit hexadecimal number), there is no way to distinguish the code generated by the pre-

processor from the rest of the code.

All of the programs were assembled using the IBM Personal Computer Macro Assembler (version 1.00) on a 128K PC with the 10-megabyte hard disk expansion chassis running DOS 2.0. Programs were linked using the DOS 2.0 version of LINK, except for the record create, read, update program, which had to be linked with the DOS 1.1 version of LINK because of problems encountered with the 2.0 version. Finally, the .COM files for actual execution were created using the DOS 2.0 version of EXE2BIN. —Louis J. Cutrona, Jr.

---

**T**HE  
*preprocessor converts  
constructs into the  
appropriate assembly  
code, relieving the  
programmer of just a  
little bit of the burden of  
assembly language  
programming.*

---

Louis J. Cutrona, Jr. provided our assembly language routines. He consults in the area of microcomputer system design and programming, specializing in the IBM Personal Computer, and recently, he taught a class in IBM Personal Computer Macro Assembler Language Programming. Dr. Cutrona is in the process of developing several utility programs for the IBM PC, including the structured assembler preprocessor program mentioned in the sidebar on assembly language. You can contact him at (201) 447-3270.

---



Figure 11: String concatenation in assembly language.

```

comment *
    This program makes use of another of the 8088's powerful instructions:
    The string move instruction ("movs") and the repetition prefix
    ("rep").

    The string move instruction causes the character located in the
    data segment at the offset specified in the source index register
    (SI) to be copied into the extra segment at the offset specified
    in the destination index register (DI), following which the source
    index and the destination index are both incremented by 1.

    The repetition prefix, which is related to the loop instruction,
    performs the following operations: If the current value of the
    count register is zero, skips the instruction to which it is
    prefixed (in this case "movsb"), and passes control to the next current
    instruction. If the current value of the count register is not
    zero, executes the string primitive instruction and then subtracts
    1 from the current contents of the count register.

    The net effect is that the "rep" prefix causes the repeated
    execution of the string primitive instruction, the number of
    repetitions being determined by the number stored in the count
    register (CX) when the repetition starts.
    *

cseg    segment                ;Identifies the start of a logical segment of assembler code.
        assume cs:cseg,ds:cseg,es:cseg ;This is what the assembler needs to know to address data.

        org    120H            ;Locate data area after code, but declare it first.

a$      db    "This is a string"
length_a$ equ    $ - a$        ;The special symbol "$" stands for the current value of the
                                ;location counter, a value often represented in other
                                ;assemblers by the special symbol "**"

b$      db    "This is a longer string with lots of words in it."
length_b$ equ    $ - b$
c$      db    length_a$ + length_b$ dup(?)

        org    100H            ;Code starts here for a .COM file

initialize:
        cld                    ;Set the direction flag so that the string primitives
                                ;will work from lower to higher memory locations.
                                ;If we had set this flag to 1, using "std", then the
                                ;string primitive instructions would decrement the
                                ;source index and destination index each time instead
                                ;of incrementing.

next_x:  mov     cx,10000        ;Set number of times to repeat the loop

        mov     ax,cx           ;Save the current value of the loop counter into the A-register.

        mov     si,offset a$    ;Put the offset of a$ in the data segment into the source index.
        mov     di,offset c$    ;Put the offset of c$ in the extra segment into the destination index.
        mov     cx,length_a$    ;Put the number of characters in string a$ into the count register.
        rep     movsb           ;Copy the characters from a$ into c$

        mov     si,offset b$    ;Put the offset of b$ in the data segment into the source index
                                ;The destination index is already pointing to the next character
                                ;in c$ because that's how the preceding "rep movsb" left it.
        mov     cx,length_b$    ;Put the number of characters in string b$ into the count register.
        rep     movsb           ;Copy the characters from b$ into c$

        mov     cx,ax           ;Retrieve the current value of the loop counter.
        loop    next_x          ;and repeat the above until the counter hits zero.

        int     20H            ;Return to DOS

cseg    ends                    ;Identifies the end of the logical segment named "cseg"
        end     initialize      ;Tells the assembler where execution is to begin.

```



Figure 12: A record/create/read/update program in assembly language.

```

include doscall.###
include fcb.asm

cseg      segment
          assume  cs:cseg,ds:cseg

          org     200H
diskfile  fcb     <0,"TEST  ", "DAT">    ;Define FCB for disk file.
new_data  db     "Modified"
length_new_data equ  $ - new_data
record_area db    132 dup(" ")          ;Initialize to blank as BASIC does.

          org     100H

initialize:
doscall   set_dta,record_area             ;Specify location of program's input/output buffer
doscall   create_file,diskfile            ;Create a file named "TEST.DAT"
mov       diskfile.lrecl,132             ;Set logical record length to 132
xor       bx,bx                          ;We will use BX as the record number counter

;repeat
x0001x:
          inc     bx                     ;Next value of record number counter
          mov     diskfile.relrec,bx      ;Set record number field in FCB
          doscall random_write,diskfile   ;Write contents of record_area to file.
;until bx,ae,100
          cmp     bx,100
          jnae    x0001x

          xor     bx,bx                  ;Zero BX for use as counter for reading back

;repeat
x0002x:
          inc     bx                     ;Next value of record number counter
          mov     diskfile.relrec,bx      ;Set record number field in FCB
          doscall random_read,diskfile    ;Read contents of record into record_area
;until bx,ae,100
          cmp     bx,100
          jnae    x0002x

          doscall close_file,diskfile     ;Close the file

;Part 2 - modify and rewrite records

          cld                           ;Make string primitives increment
          doscall open_file,diskfile      ;Open the file
          mov     diskfile.lrecl,132      ;Set logical record length to 132
          xor     bx,bx                  ;Zero BX for use as counter for records modified

;repeat
x0003x:
          inc     bx                     ;Next value of record counter
          call    read                   ;Call subroutine to read record number in BX
          mov     si,offset new_data      ;Point to new data
          mov     di,offset record_area   ;Point to input/output area
          mov     cx,length_new_data      ;Tell how many characters to move
          rep movsb                       ;Copy characters into record area
          call    write                  ;Call subroutine to write modified data
;until bx,ae,100
          cmp     bx,100
          jnae    x0003x

          doscall close_file,diskfile     ;Close the file
          int     20H                   ;Return to DOS

;Subroutine to read the record specified in BX
read      proc    near                  ;Tell assembler this is a NEAR subroutine
          mov     diskfile.relrec,bx      ;Set the record number to be read
          doscall random_read,diskfile    ;Read it in
          ret                                           ;Return to caller
read      endp                          ;Tell assembler that's all for this subroutine

;Subroutine to write the record specified in BX
write     proc    near                  ;Tell assembler this is a NEAR subroutine
          mov     diskfile.relrec,bx      ;Set the record number to be written
          doscall random_write,diskfile    ;Write it out
          ret                                           ;Return to caller
write     endp                          ;Tell assembler that's all for this subroutine

cseg      ends
          end      initialize

```

Figure 13: Pascal's string concatenation operator CONCAT is straightforward.

```

program string_concatenation;
var x : integer;
    a,b,c : lstring(80);
begin
  for x := 1 to 10000 do
  begin
    c := 'This is a string';
    b := 'This is a longer string with lots of words in it';
    concat(c,b)
  end
end.

```

Figure 14: The read/write modify program in Pascal.

```

program records(input,output,fyle);
const bell = 7;
type rec = packed record
    data : lstring(132);
end;
var x : byte;
    fyle : file of rec;
begin
  assign(fyle,'test.dat');
  fyle.data := 'Creation';
  rewrite(fyle);
  for x := 0 to 99 do put(fyle);
  close(fyle);
  writeln(output,chr(bell));
  reset(fyle);
  for x := 1 to 99 do get(fyle);
  close(fyle);
  writeln(output,chr(bell));
  fyle.mode := direct; { allows random access }
  reset(fyle);
  for x := 0 to 99 do
  begin
    seek(fyle,x);
    get(fyle);
    fyle.data := 'Modified';
    seek(fyle,x);
    put(fyle);
  end;
  close(fyle);
end.

```

Figure 15: String concatenation in FORTH.

```

Block: 127
0 { 06/29/83 - PC Magazine benchmark programs, in MMFORTH }
1 { TASK : STRINGS 9 Load STRINGS word set }
2 255 VARIABLE A-STRING
3 255 VARIABLE B-STRING 255 VARIABLE C-STRING
4 { STRING-CONCAT
5 " This is a string" A-STRING !
6 " This is a longer string with lots of words in it."
7 B-STRING ! 10000 0
8 DO A-STRING B-STRING !+ C-STRING 41 LOOP ;

```

Figure 16: Record Management function in FORTH.

```

Block: 129
0 { 06/29/83 - PC Magazine benchmark programs, in MMFORTH }
1
2 { Record create, read, update } TASK ;
3 STRINGS { Load STRINGS word set }
4 BLK # 1+ CONSTANT FILE-AREA { File area to start in next blk }
5 { RECORD-AREA 7 /MOD FILE-AREA + BLOCK SNAP 132 * + ;
6 { CLEAR-FILE 100 0
7 DO 1 RECORD-AREA 132 BLANK UPDATE
8 LOOP FLUSH ;
9 { READ-RECS 100 0 DO 1 RECORD-AREA DROP LOOP ;
10 { MODIFY&REWRITE 100 0
11 DO " Modified" 1 RECORD-AREA ! UPDATE
12 LOOP FLUSH ;
13 { RECORD-TEST CLEAR-FILE READ-RECS MODIFY&REWRITE ;
14
15

```

across the street from the World Trade Center in New York's financial district. Wisan can be reached at (212) 608-4000.

Notice the working storage section for this version of the string concatenation program (see Figure 9). It requires you to specify the length of each string as well as its contents.

The read/write/modify program (see Figure 10) gives you an idea of how COBOL programs begin to look in a business environment. The FD in the data division describes the records to be created and used by the program.

**T**HERE IS  
a certain undefinable  
way in which a  
language meshes with  
your personality.

## ■ ASSEMBLY

The program shown in Figure 11 makes use of one of the 8088's powerful instructions: The string move instruction (movs) and the repetition prefix (rep). The string move instruction causes the character located in the data segment at the offset specified in the source index register (SI) to be copied into the extra segment at the offset specified in the destination index register (DI), following which the source index and the destination index are both incremented by 1.

The repetition prefix, which is related to the loop instruction, performs the following operations: If the current value of the count register is zero, it skips the instruction to which it is prefixed (in this case, "movsb"), and passes control to the next current instruction. If the current value of the count register is not zero, it executes the string primitive instruction and then subtracts 1 from the current contents of the count register.

The net effect is that the "rep" prefix causes the repeated execution of the string



primitive instruction, the number of repetitions being determined by the number stored in the count register (CX) when the repetition starts.

The final assembly language program (see Figure 12) uses two included files, one that makes DOS calls easier, and one that helps the programmer in setting up file control blocks.

### ■ Pascal

Pascal's string concatenation operator, CONCAT, is straightforward (see Figure 13). Note that the length of the strings must be declared in the beginning of the program.

The read/write modify program (see Figure 14) uses two file modes, sequential and direct. The files are created and read sequentially and then modified in direct or random mode.

### ■ FORTRAN

Edie Windsor, who provided our FORTRAN routines, is a native of New York City who worked in various capacities for IBM over a period of 16 years. She has been involved with FORTRAN since her early research in 1956 at NYU, where she worked on iterative solutions to 4th order differential equations. A year later she authored the NIM program that IBM distributes with updates to 704 FORTRAN.

At IBM, she was a Senior Programmer in the Systems Development Division, specializing in specification design, implementation of systems, and language processors, as well as architecture systems requirements, product planning, and strategies. She has extensive experience with FORTRAN on the IBM 704, 709, 7090, 7040/44, the 360 series, the 370 series, and others.

Edie subsequently managed an IBM group responsible for FORTRAN, COBOL, and Algol standards; and was responsible for IBM's Corporate Language Strategy.

In FORTRAN, strings are handled as arrays of individual characters, which accounts for its low performance in the benchmarks (see Figure 22).

The file handling program shows the detailed specifications that FORTRAN requires in order to process them properly

Figure 17: APL string concatenation.

```

▽ PROBS1 C;N
[1]  N←0
[2]  LOOP←0×10000÷N+N+1
[3]  A←'THIS IS A STRING'
[4]  B←'THIS IS A LONGER STRING WITH LOTS OF WORDS IN IT.'
[5]  C←A,B
[6]  +LOOP
▽

```

Figure 18: APL floating point.

```

▽ PROB4 N
[1]  VB←N÷1234.56
[2]  VC←N÷78.9
[3]  VA←VB×VC
[4]  VA←VB÷VC

```

Figure 19: String concatenation in dBase II.

```

* dBase II string concatenation.
* Note that all memory variables must be
* assigned a value before they can be referenced.
? "starting..." + chr(7)
set talk off
STORE 1 TO X
DO WHILE X < 10001
  STORE 'This is a string' TO A
  STORE 'This is a longer string with lots of words in it.' TO B
  STORE A+B TO C
  STORE X+1 TO X
ENDDO
CLEAR
set talk on
? "finished!" + chr(7)

```

Figure 20: dBase II file update program.

```

* dBase II file update program.
* This program uses a pre-defined 132 byte
* file to be created, read and updated.
USE TESTDB
? "starting..." + chr(7)
set talk off
STORE 1 TO X
DO WHILE X < 101
  APPEND BLANK
  REPLACE FIELD1 WITH X
  STORE X+1 TO X
ENDDO
CLEAR
USE TESTDB
STORE 1 TO X
DO WHILE X < 101
  STORE FIELD1 TO A
  STORE X+1 TO X
  SKIP
ENDDO
CLEAR
USE TESTDB
STORE 1 TO X
DO WHILE X < 101
  REPLACE FIELD2 WITH "Modified"
  STORE X+1 TO X
  SKIP
ENDDO
CLEAR
set talk on
? "Finished!" + chr(7)

```

Figure 21: PL/I programs.

```
test4: procedure options(main);
declare i fixed binary;
declare s character(16);
declare t character(32);
declare r character(48);
do i = 1 to 10000;
s = 'This is a string';
t = 'This is a longer string with lots of words in it';
r = s || t;
end;
end test4;

test6: procedure options(main);
declare i fixed binary;
declare f file;
declare record character(132);

record = ''; /* all blanks */

open file(f) title('PCMAG.DAT') record output;
do i = 1 to 100;
write file(f) from(record);
end;
close file(f);

open file(f) title('PCMAG.DAT') record input;
do i = 1 to 100;
read file(f) into(record);
end;
close file(f);

open file(f) title('PCMAG.DAT') record output;
do i = 1 to 100;
record = 'Modified';
write file(f) from(record);
end;
close file(f);

end test6;
```

Figure 22: String concatenation in Fortran.

```
PROGRAM STRING
CHARACTER A*17,B*49,C*67
DO 40, I=1,10000
A = 'This is a string.'
B = 'This is a longer string with lots of words in it.'
40 WRITE(C,'(A,A)') A,B
WRITE(*,'(A)') C
STOP
END
```

Figure 23: File create/read/update in Fortran.

```
PROGRAM FILEHAND
CHARACTER*66 B,C, FI*10
CHARACTER INIT
DIMENSION B(101),C(101)
INIT = 'Y'
FI = '#5:TESTDAT'
OPEN 5,FILE =FI,STATUS='NEW',ACCESS='DIRECT',
1FORM='UNFORMATTED',RECL=132
DO 40, I=1,100
WRITE(5,REC=I) INIT
40 CONTINUE
CLOSE(5,STATUS='KEEP')
OPEN 5,FILE =FI,ACCESS='DIRECT',FORM='UNFORMATTED',RECL=132
DO 50, I=1,100
READ(5,REC=I) B(I),C(I)
50 CONTINUE
CLOSE(5)
OPEN 5,FILE =FI,ACCESS='DIRECT',FORM='UNFORMATTED',RECL=132
DO 60, I=1,100
B(I) = 'MODIFIED'
60 WRITE(5,REC=I) B(I),C(I)
CLOSE(5)
PAUSE
OPEN 5,FILE =FI,ACCESS='DIRECT',FORM='UNFORMATTED',RECL=132
READ(5,REC=20) B(101),C(101)
WRITE(*,'(A)') B(101)
CLOSE(5)
STOP
END
```

(see Figure 23).

## ■ APL

Bob Lee provided our APL routines. He is a research psychologist who specializes in public opinion and consumer research. He first became acquainted with APL while performing survey studies in the late 1960s, and spent 20 years using the language as a communications researcher at IBM. He has developed courses in computers for executives in the educational field, and has taught numerous classes at IBM Systems Research Institute, NYU, and elsewhere.

APL, the language with all of those funny symbols in it, sure saves your typing fingers if not your eyes.

The Floating Point Benchmark in APL does not require looping (see Figure 18). The header for the program defines this as a function that takes one argument, in this case N, which is the number of times the pair of floating point operations is to be performed.

Line 1 creates a vector named VB with N elements, each with a value of 1234.56. Line 2 makes the VC vector, with N elements, each valued at 78.9. The two vectors are then multiplied element by element in Line 3 with the resulting vector of N products assigned to a new vector called VA. In Line 4, the vector VB is divided by vector VC and assigned to VA again. Note that APL uses an "x" for multiplication; the "\*" is used for exponentiation.

APL calls concatenation "catenation" for some reason. We will need to set up a loop, as used in the empty loop benchmark (see Figure 17).

The counter, N, is set at 0 in the first line. The second line, labeled LOOP, works in the same way as the empty loop benchmark. Here, though, instead of using the labeled line OUT as an escape, we simply direct the program to the nonexistent line 0 when 10,000 is less than is true. (This is the obverse to the BASIC and FORTRAN operations which continue until N is greater than 10,000.)

Line 3 creates the first character string and assigns it to A; Line 4 the second string for variable B. In Line 5, the two strings are catenated by use of a comma and assigned to variable C. Line 6 branches back to LOOP.



## ■ FORTH

FORTH'S unique flavor can be seen from the figures representing our benchmarks.

Other than empty loop, string concatenation may be the most recognizable in terms of deducing how the program works without a working knowledge of FORTH. See Figure 15. Remembering to read right to left, the array reading task is rendered cleanly in FORTH. MMS's version of FORTH is among those with a full disk I/O capability. Although it does not run with MS/DOS (FORTH is an operating system complete unto itself), the record management functions are complete (see Figure 16).

## ■ C

Randall Swan, who provided the C routines shown below, is president and founder of the C-Team, a consulting firm that is designing several C language products, including a C screen editor, a package to translate BASIC into C, and a screen window manager. For the past several years, Swan has been providing turnkey computer systems to vertical markets such as the medical field. He may be reached at The C-Team, 60 East 12th Street, New York, NY 10003 (212) 477-0253.

## ■ dBase II

dBase II's syntax comes from some of the best features the structured languages

have to offer in terms of clarity. There is no GOTO. The sample programs are utterly readable and are probably closer to English than any other language represented. Note that the language does not contain any count-limited looping ability, but must increment a variable and check its value through use of the WHILE statement. Thus, there is no such thing as an "empty loop" in dBase and there is no equivalent benchmark. Similarly, there is no way to declare or access an array, and, consequently, no table lookup benchmark. From the performance tests, it is obvious that asking dBase to do something 10,000 times is not what it was designed for at all (see Figures 19 and 20).

Figure 24: C language concatenation program.

```
main() /*      Example 4      Without pointers is slower.      */
{      /*      String concatenation with 10,000 iterations      */

    char str1[18]; /* Declare string1 as an array of 18 characters */
    char str2[50]; /* Declare string2 as an array of 50 characters */
    char str3[80]; /* Declare string3 large enough to hold both    */
    int i=10000;   /* Initialize i for 10K loop                    */

    while(i--)
    {
        strcpy(str1,"This is a string.");
        strcpy(str2,"This is a longer string with lots of words in it.");
        strcpy(str3,str1); /* String copy str1 into str3.      */
        strcat(str3,str2); /* Concatenate str2 onto str3.      */
    }
}

main() /*      Example 4a      Pointers used for strings is faster. */
{      /*      String concatenation loop with 10,000 iterations      */

    char *str1; /* string1 is a pointer to char text */
    char *str2; /* string2 is also a pointer to char text */
    char str3[80]; /* string3 is an char array for concatenation */
    int i=10000; /* Index count starts with 10K & steps down to 0 */

    while(i--)
    {
        str1="This is a string.";
        str2="This is a longer string with lots of words in it.";
        strcpy(str3,str1); /* String copy from str1 to str3 */
        strcat(str3,str2); /* Concatenate str2 onto str3      */
    }
}
```

Figure 25: C language direct access disk I/O.

```

/*      Example 6      Direct Access Disk I/O.
There are three phases to this program to demonstrate
direct access (random access) disk I/O in C.
Lattice extends the UNIX view of buffered file
control but is fundamentally the way most
non-UNIX C operating systems, ie. PC-DOS, do it.
Social tradition of these non-UNIX compilers
is the only thing that deems C I/O so similar
and has eased the portability of source code,
but does not guarantee it by any means.
There is no standard of adherence for I/O in C,
only tradition dictates, and it is a strong one.

The 'fseek' statement is how record positioning
is controlled relative to the beginning, the end,
or the current location.

Only one record of the datafile is kept in the
program memory at any time.

Phase I creates 100 blank filled 132 byte records onto disk.
Phase II reads all 100 recs back from disk.
Phase III reads in a record & then writes it back out,
one record at time for all 100, just as
if an update to the record were performed.
*/

#include      "stdio.h"      /* Standard Library for Disk I/O      */

main()
{
    char rec[133]; /*      The record is made of 132 blanks plus
                        a terminating byte.      */
    FILE *fp;      /*      File pointer for buffered (level 2) I/O.      */
    short i;       /*      This little guy is used to count to 100      */

    /*      The Make String function creates an indicated # of bytes      */
    strnak(rec, ' ', 132);

    /*      Create the datafile or bitch.      */
    if( (fp = fopen("TEST.DAT", "w")) == NULL )
    {
        puts(" Error: Can't create file 'TEST.DAT' for output.");
        exit(); /* quit out, can't stand it anymore.      */
    }
    else
    {
        /*      Phase I      Write 100 blank records      */
        for( i=1; i<=100; i++)
            fputc(rec, fp); /* Write'm out baby!      */
        fclose(fp); /*      Close down the disk file      */
    }

    /*      Reopen datafile in append mode or bitch about it.      */
    if( (fp = fopen("TEST.DAT", "a")) == NULL )
    {
        puts(" Error: Can't open file 'TEST.DAT' for I/O.");
        exit(); /* quit out, that's all she wrote folks      */
    }
}

```



# End Statements

■ *Even though you didn't get to choose your own native tongue, you can choose one for your PC.*

Is there a "best" language? Probably not. Some readers might criticize our benchmarks for not being "real-world" examples, but that was not our intention; we simply wanted to show similarities and differences in syntax and structure among the languages presented.

It's impossible to do an article such as this and not draw some conclusions. Without getting into overly complex and controversial areas, it's obvious that there are some very fast compilers in our sampling. There is also a middling fast compiler and a dead-slow interpreter. Some of dBase II's times sparked comments about hoping the sun would stay out long enough to get an accurate reading from the sundial. Does this mean that we're going to give up dBase II for all those in-house filing and list management chores? Not on your life. dBase II's strong suit is in-line processing of records, and selecting and indexing them according to your needs. It's also pretty good at handling screens. They weren't in the benchmark test because all of the pure programming languages would have fallen miserably short in ease of development of a given application, even if the end result ran many times faster. There are many occasions when slow is fast enough.

In the same vein, witness the unsinkable BASIC interpreter. Forget operating systems. Forget snazzy spreadsheets. Hang up your modem, and, for that matter, junk your PC. The real hero of the personal computer revolution is BASIC. Microsoft's prodigal program has coaxed out the programmer hidden within so many of us that it is and will continue to be an integral part of the personal computer scene for many years to come. True, BASIC is slow compared to the compilers, but not laughably slow. It will probably hold off LOGO as the interpretive language of choice for another 3 to 5 years. Okay, it's inelegant and the line numbers are a pain. It lacks

control structures and records. But you can bang out a quick and dirty program to reformat your spreadsheet files, filter offensive characters from a word processing document, or write a game to amuse your kids or yourself.

Style is important when you look at a language. Flowery phrases that seem natural in Spanish simply sound stupid in English. And so it is with programming languages. Reviewing the sample programs, Pascal is probably the most elegant and cleanest, followed by your choice of the other structured languages—PL/I, C and dBase II. Pascal's deadly flaw, though, is its lack of standardization. FORTRAN's prose is probably the most turgid, while COBOL certainly wins the prize for long-windedness. APL is in a class by itself for economy of expression, but it's too abstract for many people. LOGO has a charming simplicity, but MAKE and BUT-FIRST and some of the other words sound a little contrived to my ear. The best thing about LOGO is that powerful ideas such as recursion and list processing are ex-

---

## ***T**HE REAL hero of the personal computer revolution is BASIC.*

---

pressed simply and economically.

FORTH, as other function-oriented languages, gives you the ability to code up some pretty complex stuff and reduce it to a single word. Better still, that word becomes part of your vocabulary with no further effort on your part—no libraries, macros, compilations, or assembly. On the other hand, you're manipulating a hypothetical processor in FORTH. The stack-oriented machine doesn't really exist. While this is true to an extent with other languages (you learn to think like the language's syntax checker, not the actual computer), it's far more evident in FORTH. Assembly, meanwhile, couldn't be more attuned to the processor.

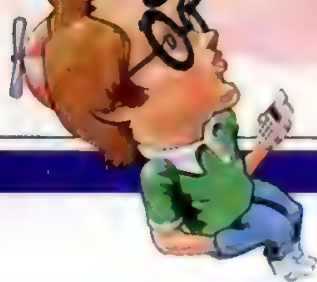
Of course, the programmer's style has a lot to do with the utility of the end result.

The C programs in this article, for example, are as heavily commented as the assembly programs. While not strictly necessary, they allow an utter neophyte to read the C programs and decipher how they work. No language is so self-documenting that it can't be improved with comments. Comments may range from lengthy dissertations down to a single character or even a punctuation mark. Making the program look easy is the mark of an accomplished programmer. Beginners tend to start writing programs before having fully analyzed the problem. Then, when things don't work, they patch and repatch the program until the listing resembles a tangle of spaghetti. While no language encourages such action, some, like BASIC, make it inviting, while others, like Pascal and C, discourage it.

Okay, you say, they've all got strong points and weak points, but surely we have some recommendations? You bet. Don't give up BASIC if you program for your own pleasure or you do graphics on the PC. If you want to see the light bulb come on over the head of a programming neophyte, let him start with LOGO or APL. PL/I, COBOL, and FORTRAN translate with relative ease to minicomputers and mainframes, while C best makes the transition to minicomputers running UNIX. It's also quite portable among personal computers. Portability questions aside, we can't see any reason why you would want to learn COBOL or FORTRAN for use on your PC. Pascal is easy to learn, although not nearly so as BASIC. So long as the implementation you choose does what you want, enjoy. Don't expect much in the way of compatibility, though, if you change from one compiler to another. Don't feel guilty if you don't like Pascal. Many converts would have you believe that it's the only solution, but frankly, the p-System is ponderous and inelegant.

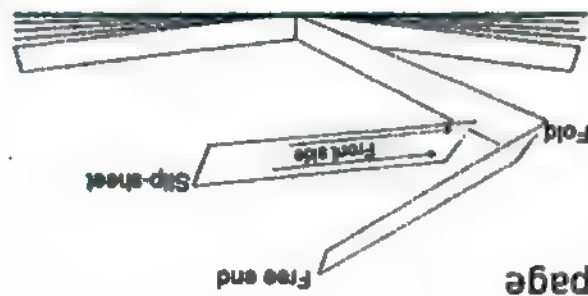
Once you choose a new language, you may have trouble figuring out whether it is elevating you to new heights of creativity or constraint. You can't own all of the great cars in the world, you can't even read all the great books. You can't know all the great computer languages, and each door that you open closes a hundred others. Choose carefully and know your needs and abilities. And once you've decided, don't look back. /PC





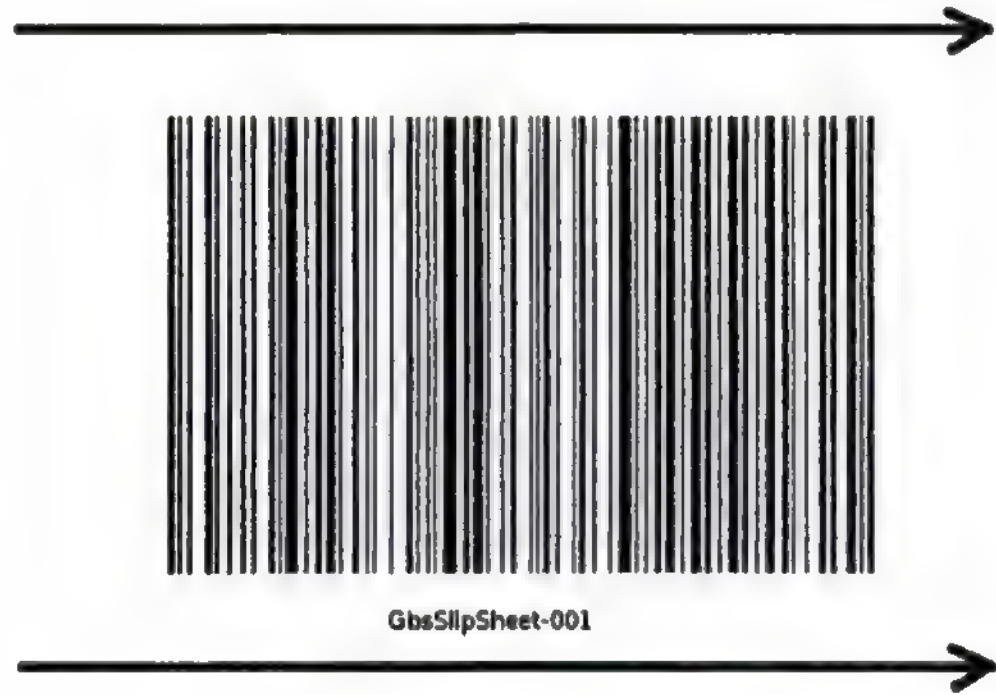
TEST 4 String concatenation		TEST 5 Table look up		TEST 6 File access		Size of run time support module (for each test)	Internal editor (yes/no)	Compile time	Overall ease of use 1-difficult 5-easy	Reader Service Card Number
TIME seconds	SIZE	TIME in seconds	SIZE	TIME in seconds	SIZE					
	1408 bytes	22	1408 bytes	39	1408 bytes	31744 bytes	No	40 seconds	4	686
8 (minutes)	256 bytes	1.58 (minutes)	256 bytes	0.40	384 bytes	16768 bytes	Yes	Not applicable	5	
07	162 bytes	1.1	142 bytes	44.2	433 bytes	Not applicable	No	40 seconds (average)	1	685
7 (minutes)	5888 bytes	3.49 (minutes)	5888 bytes	28.22	11648 bytes	16081 bytes	No	1 minute	3	
5 (minutes)	36224 bytes	.5	36096 bytes	28	30432 bytes	Not applicable	No	53 seconds	3	
9	916 bytes	3.0	154 bytes	16.4	169 bytes	18200 bytes	Yes	Not applicable	4	684
	7680 bytes	4	7680 bytes	13	8192 bytes	Not applicable	No	45 seconds	3	683
36	393 bytes	8.46	352 bytes	Not available	Not available	18000 bytes	Yes	Not applicable	5	682
06	14336 bytes	12.41	14336 bytes	28.4	11776 bytes	Not applicable	No	30 seconds	3	681
1.34 (minutes)	512 bytes	Not applicable	Not applica- ble	58	640 bytes	23168 bytes	Yes	Not applicable	5	680
5.5	Not applica- ble	0.02	Not applica- ble	Not applicable	Not applica- ble	Not applicable	Yes	Not applicable	3	679





1. Open the foldout page
2. Insert this sheet with
1. Front side touching the free page
2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet

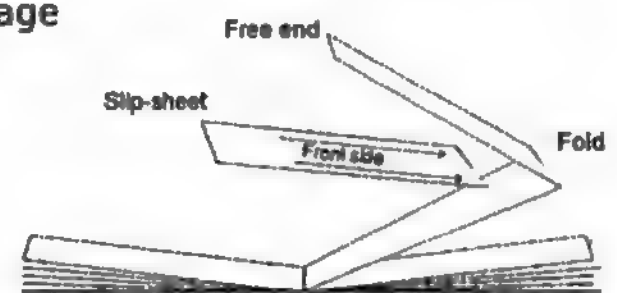
Inverted Foldout slip-sheet



Folded edge of the page

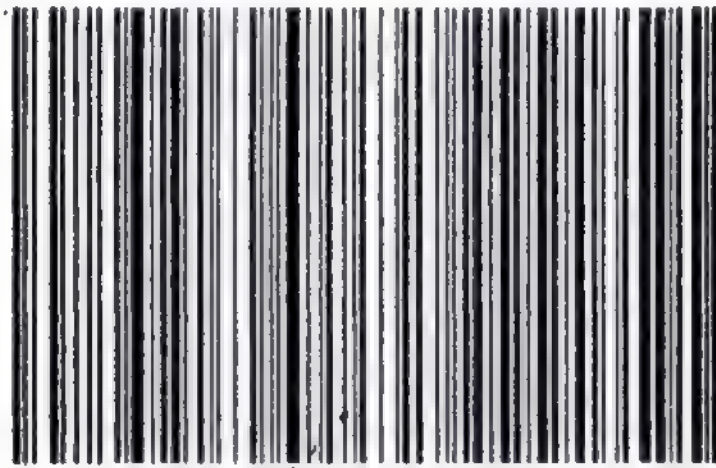
Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
  1. Front side touching the free page
  2. Arrow pointing to the fold
  3. Slice the folded edge
  4. Close the page and slip-sheet



1. Follow instructions on the other side

Inverted Back



Gbs5lipBack-0018

Back

1. Follow instructions on the other side



# A Guide To Language Performance

## Speed and Size of Object Module

Language Name and Manufacturer	List Price	TEST 1 Looping		TEST 2 Add integers		TEST 3 Floating point		Size in
		TIME in seconds	SIZE	TIME in seconds	SIZE	TIME in seconds	SIZE	
<b>BASIC Compiler</b>	<b>\$300</b>	0.2	1280 bytes	0.6	1280 bytes	14	1280 bytes	22
<b>Advanced BASIC (BASICA)</b> Microsoft 10700 Northup Way Bellevue, WA 98004 (206) 828-8080	<b>\$80</b>	5	128 bytes	17	128 bytes	1.40	128 bytes	1.1 (m)
<b>Assembler</b>	<b>\$100</b>	0.1	7 bytes	0.4	34 bytes	7.1	532 bytes	3.0
<b>COBOL</b>	<b>\$700</b>	3.3	5632 bytes	2.31 (minutes)	5760 bytes	2.56 (minutes)	5760 bytes	1.2 (m)
<b>FORTRAN</b> IBM Corporation System Product Division P.O. Box 1328 Boca Raton, FL 33432 (800) 447-4700 (800) 322-4400 Illinois (800) 447-0890 Alaska, Hawaii	<b>\$350</b>	8	35840 bytes	1.01	35968 bytes	23	35841 bytes	2.1 (m)
<b>MMS FORTH System V2.0</b> Miller Microcomputer Services 61 Lake Shore Rd. Natick, MA 01760 (617) 653-6136	<b>\$249.95</b>	0.3	22 bytes	4.3	46 bytes	26.9	126 bytes	12
<b>Lattice C Compiler</b> Lifeboat Associates 1651 Third Ave. New York, NY 10028 (212) 860-0300	<b>\$500</b>	2	7552 bytes	4	7552 bytes	1.20 (minutes)	8960 bytes	32
<b>PC Logo</b> Harvard Associates 260 Beacon St. Somerville, MA 02143 (617) 492-0660	<b>\$199.95</b>	2	53 bytes	1.28	157 bytes	3.28	265 bytes	2.1
<b>PL/1</b> Digital Research Inc. 160 Central Ave. Pacific Grove, CA 93950 (408) 649-5500	<b>\$750</b>	.33	14848 bytes	.36	14336 bytes	16.36	14336 bytes	7.1
<b>dBase II</b> Ashton-Tate 10150 West Jefferson Blvd. Culver City, CA 90230 (213) 204-5570	<b>\$700</b> (local dealers may vary)	Not applicable	Not applica- ble	17 (minutes)	256 bytes	21.31 (minutes)	384 bytes	1.1 (m)
<b>APL*PLUS/PC</b> STSC, Inc. 2115 E. Jefferson St. Rockville, MD 20852 (301) 984-5000	<b>\$595</b>	0.1	Not applica- ble*	6.4	Not applica- ble	14	Not applica- ble	20

\*Program becomes part of workspace.



# A Guide to Language Performance

*The IBM PC comes equipped with BASIC, but different applications may require a different language. Before choosing a language, you should consider your familiarity with it, the applications for which it will be used, and its ability to handle programming tasks. The following chart compares the*

*execution time and executable size of a compiled program for six basic functions for eleven different languages and compilers. The purpose of the chart is to contrast the performances of several different languages on the market. Some of the information presented here was supplied by the manufacturer.*



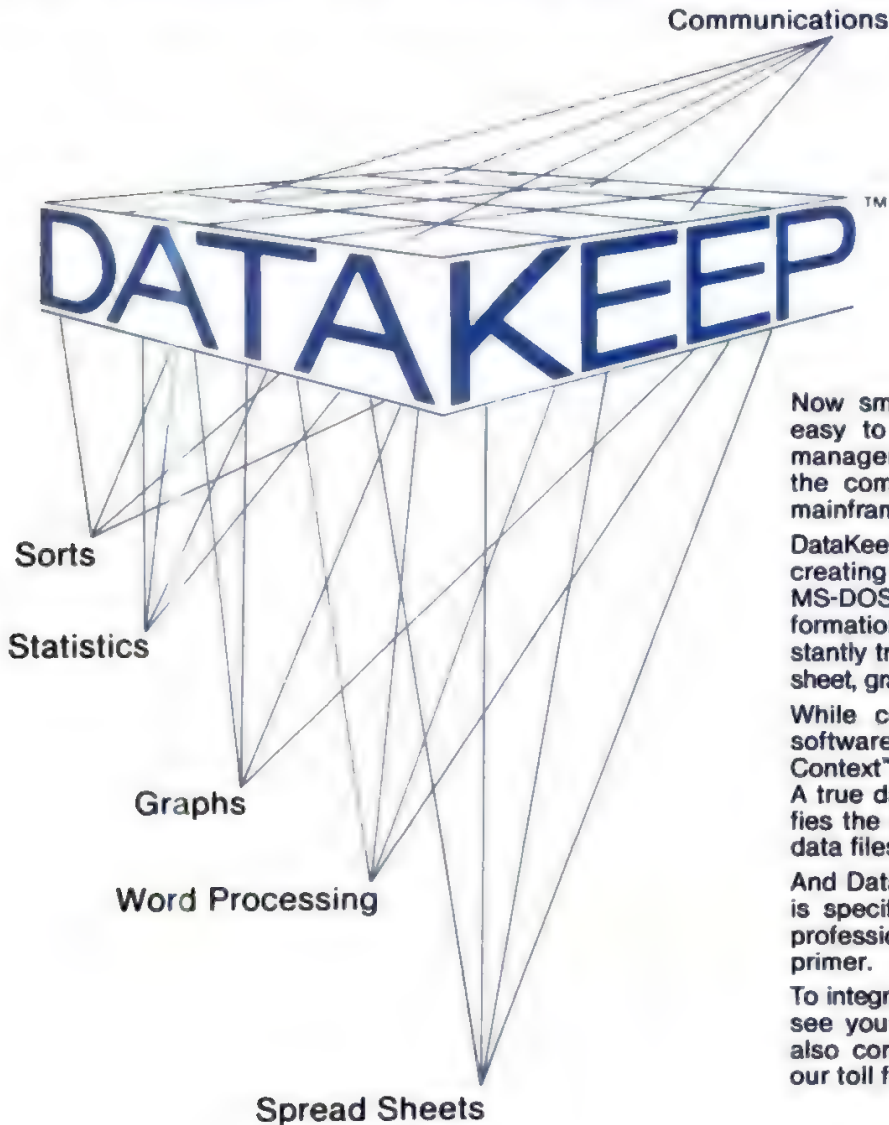


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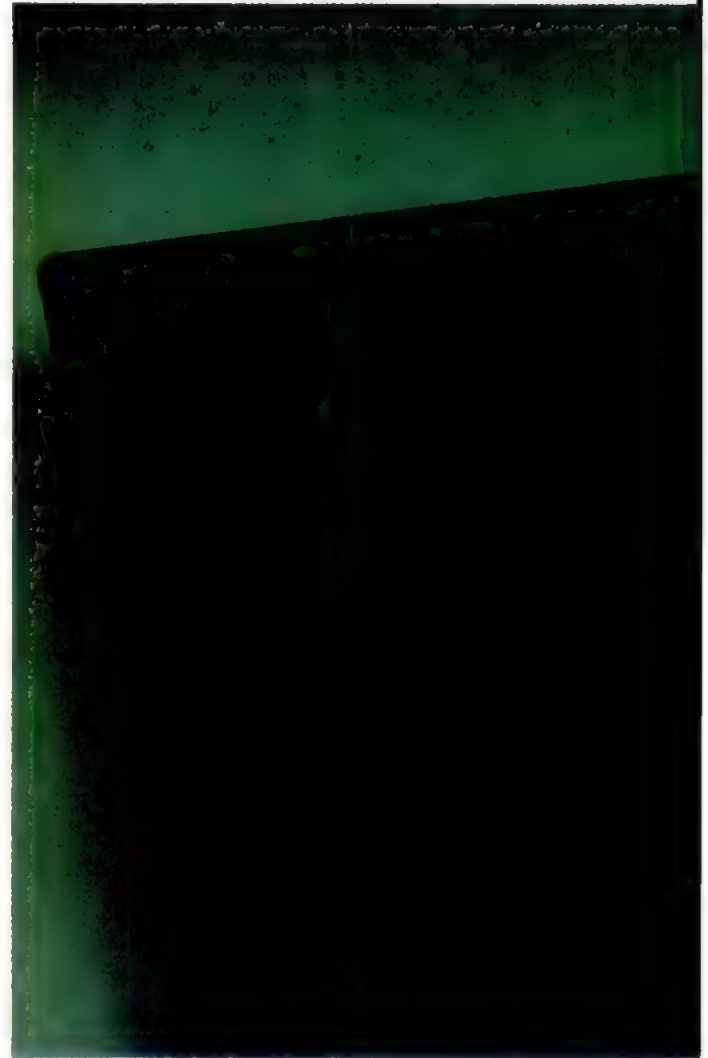
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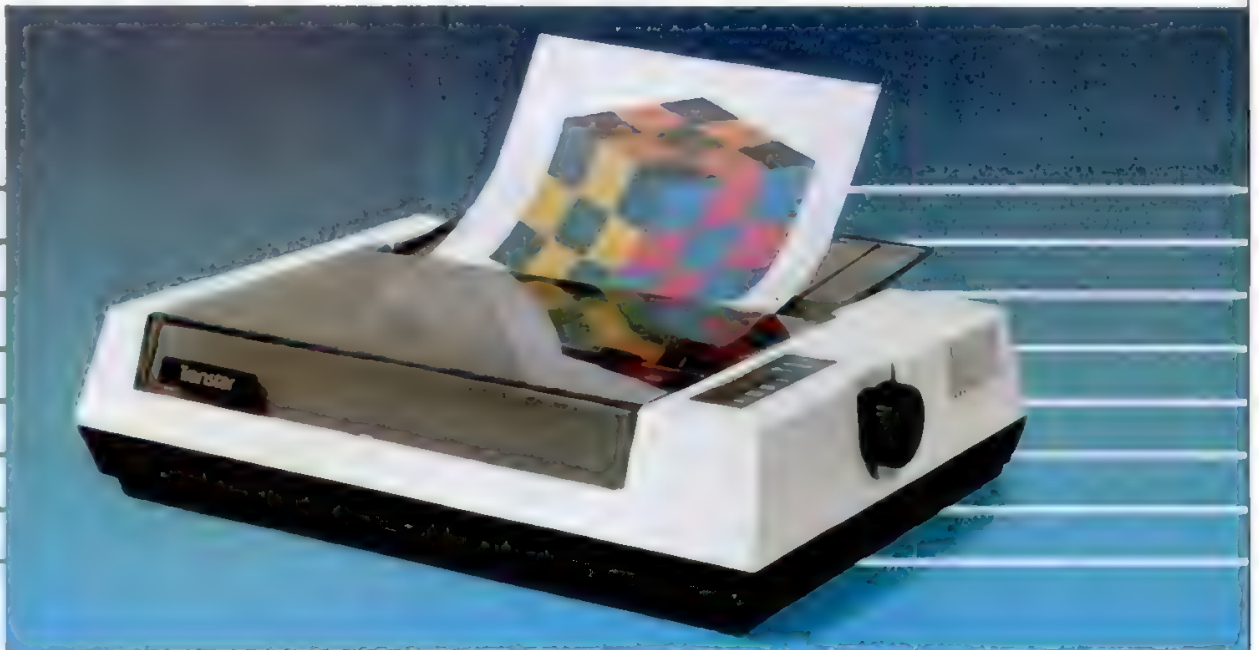
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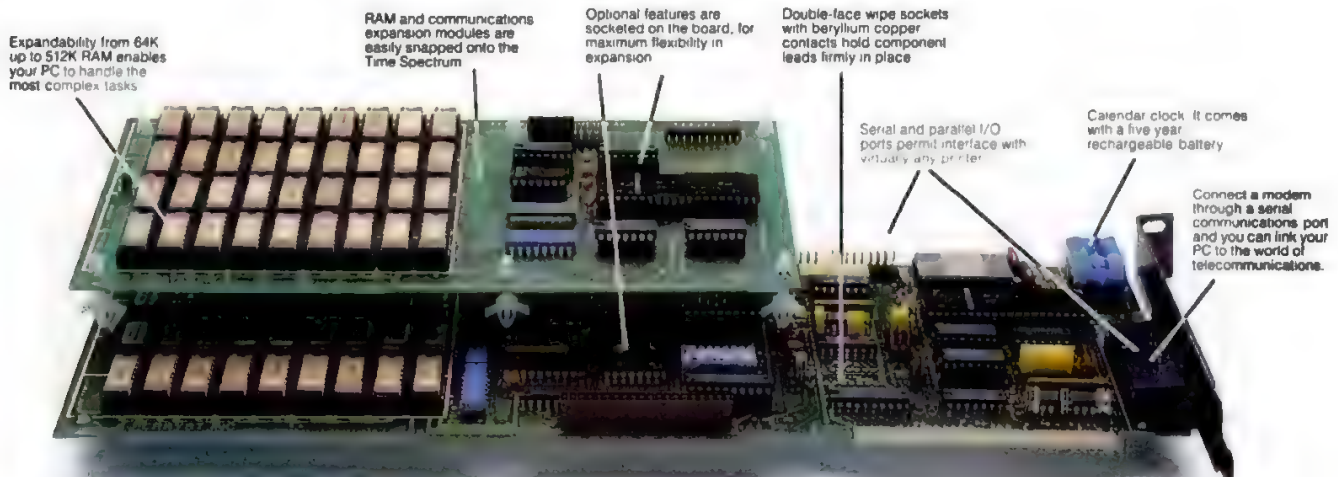
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# **THE TIME SPECTRUM BY PERSYST.**

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*Volkswriter, Snooper Troops, and 1-2-3 were not products of a moment of inspiration; they were the first culmination of three rambling, eclectic careers.*

# ON THE ROAD TO SOFTWARE STARDOM

Some of Hollywood's silliest, campiest scenarios have been cinematic attempts to explore Creativity (with a big C). You have the "Moment of Inspiration" scene in which Cary Grant, as Cole Porter, listens to the tick, tick, tock of the clock in his study, frowns, appears constipated, suddenly gasps in full lightbulb-over-the-head Eureka-dom and sits down to compose "Night and Day". Then there's the "Tortured Artiste Struggles." Merle Oberon, playing the French writer, George Sand, turns to Cornell Wilde's schnook Chopin in *A Song to Remember*, and snipes: "Discontinue that so-called polonaise jumble you've been playing for days!" Don't forget the ever-popular *Art-as-Transcendence* scene whereby the camera reverently pans from George

Gershwin's piano keyboard up into the clouds in *Rhapsody in Blue*. Presumably, when Hollywood discovers software authors, we can look forward to Busby Berkeley-like overhead views of whirling floppies and shots of function keys soaring into the stratosphere.

Part of the problem is that acts of creativity—be they of the traditional or binary variety—are usually dependent on such unsexy, nonvisual factors as luck, timing, and the ability to stay awake during the boring, workaday grind. PC recently asked three leading software designers, Camilo Wilson (Lifetree's *Volkswriter*), Tom Snyder (Spinnaker's *Snooper Troops* games), and Mitch Kapor (Lotus's *1-2-3*), to tell us about the labor pains that accompanied the birth of their programs.



# STARRING

TOM SNYDER  
SNYDER TROOPS

MITCHELL KAPOR  
1-2-3

CAMILO WILSON  
VOLKSWRITER





"The year before I did Volkswriter, I was living out in the middle of nowhere, going into San Francisco a couple of days a week, trying to make a living as a consultant," recalls Wilson. Now 36, Wilson, who had come to the United States in the 60s from Chile to study math at Berkeley, fooled around on lots of mainframes, and later gravitated toward New York, where he did computer consulting work on Wall

## WHILE our romantic hero was struggling to put it all together, IBM announced the PC.

Street, got involved in the human potential movement, and wound up working for the book division of the Arica Institute. Then Wilson fell in love with a Californian lady and abruptly switched gears—not to mention coasts.

### Book to Word Processor

It was while our romantic hero was struggling to put it all together that IBM announced the PC in August, 1981. Since Wilson was among a fairly small number of people who had experience both in computers and in publishing, it seemed like a good idea to write a book about the PC. After signing a contract with Berkeley's And/Or Press, he headed down to ComputerLand and bought one of the first PCs off the assembly line, and one of the first copies of the by-now-infamous EasyWriter 1.0. "The horrors of EasyWriter were such that I decided to write my own word processor to get the book done," Wilson said. It is perhaps an indicator of the man's essential nerd-genius that he blithely adds, "Of course, I had to quickly learn Pascal, because there wasn't an IBM assembler available then, but since I already knew a half dozen assembly languages, that part was fairly easy."

"At the end of 2 weeks, I knew I had a viable word processor," Wilson recalls. Then came the Moment of Inspiration: "I realized, here was the opportunity I had been looking for, and what the hell?" And/Or Press agreed to forget about the IBM

book and instead publish the word processor, a move that it unquestionably does not regret, since Volkswriter has sold over 25,000 copies. There followed 3 months of toothpicks-holding-the-eyes-open, losing-track-of-time, sweaty, nitpicking work, all of it handicapped by the fact that, as Wilson puts it, "in the early days of the PC, nobody wanted to tell you anything." (The IBM Technical Reference guide wasn't even out yet.) Wilson credits his girl friend with being tremendously supportive during this period, but he adds, "It was like the worst of college exams."

One ongoing source of fingernail biting was the incipient entry of MicroPro's venerable WordStar into the IBM field. "Every week, we'd go down to ComputerLand, and they'd tell us that WordStar was due in the following week," recalled Wilson. One tack he took was to carve out a slightly different piece of the market. Whereas WordStar is full-featured but sometimes hard to learn, he went for ease of use every time. Another plus: Wilson's program came preconfigured for a variety of printers, whereas the first WordStar release for the PC worked only with the IBM/Epson printer. Wilson and his lady friend decided to call the product Volkswriter, a tribute to the similarly plain-but-reliable Volkswagen. "Most of the other word pro-

cessing programs on the market had these outer-space-sounding names like WordStar and Magic Wand and Electric Pencil, and we wanted something down-to-earth," they said. (Lifetree, the name of their Monterey firm, was a deliberate spoof of Lifeboat, the New York software distributor, and Peachtree, the Atlanta software company.)

The marketing of Volkswriter, according to its author, was even more nerve-racking than the programming, largely due to fears that MicroPro would blow all competition out of the water. Early on, Wilson decided that it was absolutely imperative to have the product ready in time for the West Coast Computer Faire in the spring of 1982. "Our booth got an enormous amount of coverage, because we were the first non-IBM word processor on the market for the PC," recalled Wilson. Lifetree also took out "a little teeny tiny black and white classified" (see Figure 1) in one of the early issues of PC. From those two events, a star was born. As it turned out, MicroPro didn't put WordStar on the shelves until fully 6 weeks after Volkswriter appeared.

Why was Wilson able to be first on his block? Perhaps, he modestly suggests, "it's because I was never really in the 8-bit world; in fact, I've never used an 8-bit computer. I suppose I didn't know enough to be intimidated." He also believes that Lifetree was "always willing to walk the extra mile" in terms of customer support and dealer relations in an era of absolute chaos in the microcomputer business. The first version of Volkswriter had a significant bug, and Lifetree had to recall dozens of copies. "But," says Wilson, "from day one we had a fully accessible hotline" (unlike MicroPro, whose motto often seems to be: "Ask Your Dealer"). Lifetree, mean-

Figure 1: Lifetree, the company founded by Camilo Wilson to market Volkswriter, took the plunge and bought classified space in an early edition of PC Magazine to promote what it then called Plainwriter, a name that, fortunately, did not stick.

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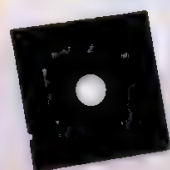
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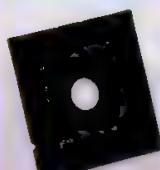
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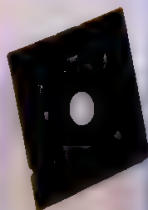
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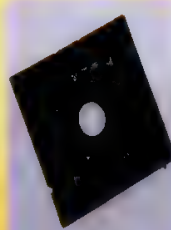
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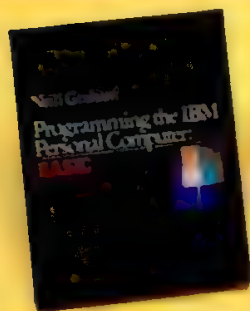
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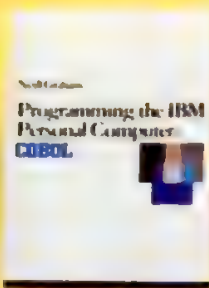


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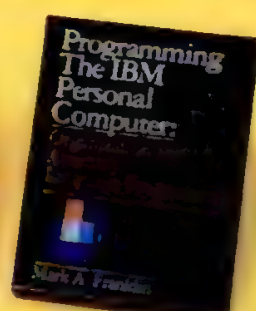


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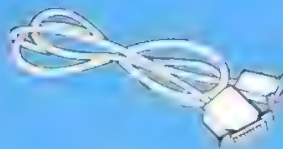
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## My Pal, IBM . . .

Like Wilson, Tom Snyder had one of those eclectic and rambling careers, which, in perfect flashback, seems destined to lead to software stardom. As a 14-year-old in Wellesley, Massachusetts, Snyder, now 33, designed digital comput-

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**THE  
relationship between  
kids and computers  
interests me not at all.  
What I care about is the  
relationship between  
kids and kids.**

---

ers for fun. "At one point," he recalled, "I jotted down a couple of circuits and sent them to a guy at IBM. Shortly afterward, I came home from school one day and found a couple of thousand dollars worth of hardware parts on the lawn that had been dropped off by a truck, with a note from IBM that said something to the effect of, 'If you design anything else, think of us.' Ever since then, I've kinda had a soft spot for IBM."

But, other things intervened: "To be brutally frank, I discovered adolescent sex and graduated from that whole nerdy thing." Snyder went on to major in French at Swarthmore, join a rock band (he recorded on Capitol in the late 1960s), get a master's in education at Lesley College in Cambridge, Massachusetts, and join the staff of the Shady Hill alternative school in Cambridge as a science and music teacher.

Early in his teaching career, Snyder invented a primitive, computerized robot as a teaching aide. The robot became so famous on the education circuit that in 1978 Parker Brothers expressed an interest in buying the design. In what has since become a notorious Tom Snyder anecdote, he somehow managed to "forget" what day the appointment with Parker Brothers was scheduled, and to arrive in the right place a day late. Snyder now says that he had one of those rare epiphanies when one understands exactly what he's doing. In his case, it was making sure that

he didn't get involved in commercial success he wasn't emotionally prepared to handle. On the way home from the nonexistent meeting with Parker Brothers, Snyder bought a Radio Shack computer.

Before long, of course, he began to bring the computer to school and to play with it manically between classes. And also before long, it occurred to him that it could be a marvelous classroom tool. "I had no intention of writing educational software—none at all!" Snyder insists. "And the relationship between kids and computers interests me not at all. What I care about is the relationship between kids and kids. There's this 60s bias of mine, that group dynamics are important. I realized I could use the computer to enhance that."

Thus Snyder drifted into writing games that demanded cooperation and collaboration among the kids in the class. He did this chiefly by having more information flash on the screen than any one child could handle. While one kid would write down, say, a clue to solving a problem about the ocean, the other kids would have to watch the screen for the next clue, and everyone would have to share clues to get the answer.

Another Snyder premise was that kids should walk away from the game planning and anticipating what they'll do when they resume the game. "I wanted to have the equivalent of a 'freeze button' to give the kids—in terms of formal pedagogy, a chance to digest what they've learned and to strategize," says Snyder. "You don't get that in an arcade game, although I've often thought that if Pac-Man were slowed down, it might be really interesting."

### Fiction as a Vehicle

Using these teaching insights as the basis of his software design (as opposed to setting out specifically to design a game), Snyder put together a series of problem-solving classroom games on the themes of geology, geography, energy, and other science-related topics. The classroom series was sold to McGraw-Hill for use on the Apple and TRS-80 computers and is currently in use in schools across the country. (The series hasn't been released on IBM simply because IBM has yet to make serious inroads into schools.) Meanwhile, Snyder acquired an IBM (on which he now does all his designing), and set off to write an even more elaborate educational

game for the students of another Shady Hill teacher, Ann Waddington.

The result was the Snooper Troops mystery game series: Case #1, The Granite Point Ghost, and Case #2, The Case of the Disappearing Dolphin. As with the earlier classroom series, the games emphasize cooperation and teach useful skills, from note taking to deductive reasoning. However, these are specifically designed for the home market, and the "game element is king" here. Children get to play detective, race around a computer graphics town in a "Snoopmobile," take "Snoopshots" of suspects, arrange a rendezvous at a strategically placed telephone booth, search an on-line computer database for clues about the goings-on in town, grill witnesses, and generally have a pretty exciting time, sans violence, sexism, and/or mindless joystickery. The games, along with their latest follow-up, *In Search of the Most Amazing Things*, which teaches kids to write music, read maps, fly a hot air balloon, and negotiate with aliens instead of zapping them, have been hailed as a breakthrough in kids' software.

By now, of course, Snyder's Moment of Inspiration had been many years in the making. The germ of the Snooper Troops idea was sold to a small Cambridge firm called Spinnaker, which was beginning to go after the home market. At that point, the serious debugging began. Continually testing the software on the Shady Hill kids

---

**FICTION  
resides in a different  
part of my brain, and  
things stay put there.**

---

yielded all kinds of insights and changes; for instance, Snyder's realization that, "It's better to let the kids solve everything." Where the games used to come with a predrawn map to help players maneuver around town, players now have to figure out the lay of the land from its individual sectors. (Somewhere along the way here, Ann Waddington and Tom Snyder got married, and Snyder, having apparently conquered his fear of success, formed Tom Snyder Productions.)

Snyder designs the basic shell of the programs and hires professional writers of children's mysteries to pen the actual plots of the games. "The part that makes you lose weight," according to Snyder, "is keeping the overview in one's head while dealing with all the niggling details," a problem he solves by using fiction as a vehicle. "When I first design a program, I write it out in the form of a 30-page story, something that nobody else does, and that many people find odd. But I find it's the best way to keep track of things. It's as though fiction resides in a different part of my brain, and things stay put there."

While Snyder programs in BASIC, working closely with the plot writers, other programmers, often culled from MIT and Harvard, hone the programs into assembly language. There are usually snags along the way: "I'm not a nit-picker; I'm a nit-pitcher," Snyder confesses. "I have a tendency to pitch the whole game out and start from scratch. I'll never forget the total disgust with which, on three different occasions in the programming of

Dolphin, the staff greeted my announcement that I had totally scrapped the current version."

### From TM to Lotus

Mitch Kapor, president of Lotus Development Corp. and designer of 1-2-3, the number one program in the IBM world, was a nerd *manqué* in high school in Freeport, Long Island. Kapor went on to Yale, where he spent most of his time around the college radio station. From there he worked as a deejay in Hartford, Connecticut, discovered Transcendental Meditation, bummed around Spain with the rest of the counterculture teaching TM, came back to the States to Cambridge, where his then-wife had a job, and through an accident, got a job as a programmer.

The Moment of Inspiration was still a ways off, however. The job didn't last, and Kapor went on to Switzerland before he had the enlightening realization that TM was not going to solve all his problems. Instead he got an M.A. in psychological counseling. Alas, he soon realized that he

could make a great contribution to the human service field by getting out of it. It was now 1978. On an impulse one day, Kapor bought an Apple.

"The next day I was hanging out in the computer store, and this guy, a physician who was looking for some software for his Apple to keep medical records on, came in. On the strength of having had my Apple for a day and my brief stint as a programmer, I talked myself into a consulting job with this guy for \$5 an hour," he recalled. Meanwhile, Kapor helped start the first Boston Apple users' group, took a couple of computer science courses, wrote more programs, and hung out increasingly in the micro world. "I had no long-term plan. I was just scraping along," he reminisces.

Since the micro world was a fairly tiny and incestuous one back then, Kapor soon met the men who had designed *VisiCalc*, and joined their team at Software Arts. It was Kapor who designed the interface for *VisiTrend* and *VisiPlot*—an endeavor that, among other things, led to huge royalties. The second check he received was for something like \$103,000.

Meanwhile, however, Kapor began to get restless about going off on his own. (He was disenchanted by what he describes as increasing tensions between Software Arts, and its distributor, *VisiCorp*.) He arranged to be bought off by Software Arts,

**THE NAME**  
*Lotus has no connection with any Far East yoga positions or spiritual values.*

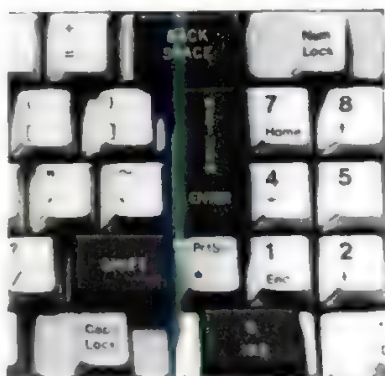
signing a contract that he now chucklingly describes as, "containing sort of a 'purloined letter.' I agreed not to compete against them directly, but I sneaked in a clause that said it was okay for me to design an integrated package. If they'd thought I could really pull it off, they'd never have signed it, but they were mostly interested in my not redoing *VisiPlot* and selling it to Microsoft."

Kapor's time at Software Arts had given him some fairly concrete ideas about

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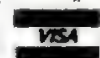
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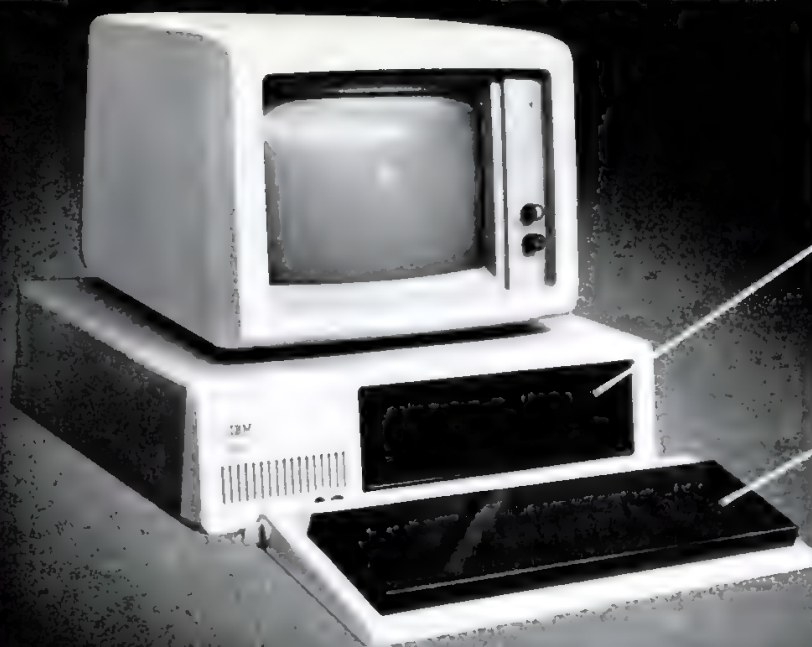
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the kind of environment he'd need to begin to develop an integrated software package. For one thing, he wanted to do his own distribution. For another, he realized that his own gifts as a programmer (he knows only BASIC) were far inferior to his gifts as a software designer. By early 1982, he had managed to hook up with both programmer Jonathan Sachs and venture capitalist Ben Rosen. Together, they founded Lotus. (The name, he insists, "has no connection with any Far East yoga positions or spiritual values or anything; I just wanted to have a name that wasn't technical.")

By now, Apple's Lisa, MBA's Context and VisiCorp's Vision were heading toward the marketplace, and Kapor knew that he had no time to waste. The original concept for 1-2-3 (then code-named "Trio") was a spreadsheet, a business graphics program, and a word processor. Says Kapor, "For a variety of reasons, we dropped the word processor. It was, number one, too hard to do. Number two, we saw MBA, and my feeling was that a data-

base was a more natural expansion of a spreadsheet. So we decommissioned the word processor and commissioned the database."

Kapor readily concedes that the design process was "agonizing" and that he was "petrified" of the competition. Still, there were comparatively few moments of true horror. "One good thing is that the program was not designed by a committee," he said. "Jon and I had a fixed amount of time. We had a deadline of January 1983 and we wanted some time before that for debugging; we had this long list of proposed features, each of them keyed according to degree of importance and difficulty of implementation." When time was short, the pair tended to throw in lots of noncritical but nice, easy-to-do features, such as 1-2-3's ability to print separate headers and footers on each page of a spreadsheet.

By the same token, a number of features were sacrificed. For example, the program has a calendar that allows the user to calculate, say, what 90 days from

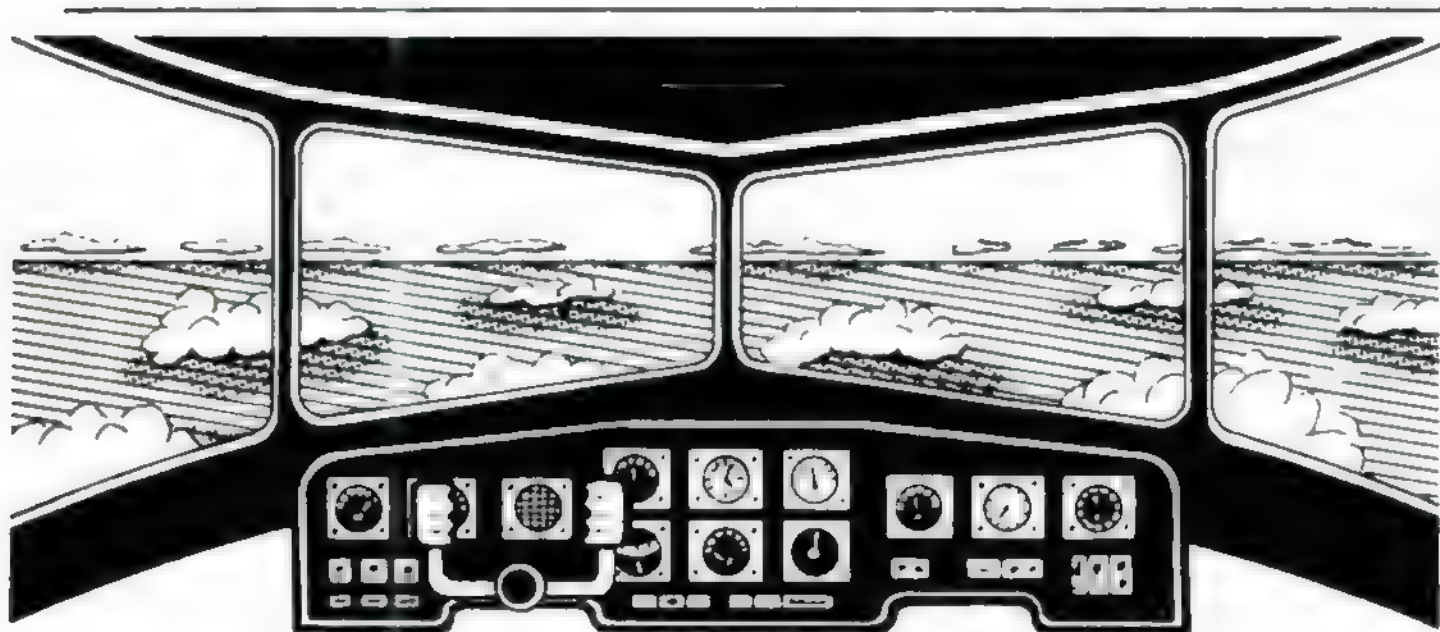
today will be. Kapor and Sachs wanted to include a similar clock function to calculate time, but their schedule wouldn't allow it. Kapor still smarts, too, about the dropping of the word processing module, an oversight that will presumably be remedied in some future version.

**LOTUS**  
spent \$1 million  
advertising 1-2-3 in *The Wall Street Journal*,  
*Business Week*, *Time*,  
*Newsweek*, and the  
computer press.

"We went into a no-fooling-around feature freeze on November 5, 90 days before we were to ship," he recalled. "We really wanted to bulletproof it, and in hindsight, that was a good decision, too, because there were no major bugs." Another decision was to bet all the marbles in marketing the product, since Lotus reasonably feared that the VisiCorp name had such brand loyalty that Lotus might not be able to get people even to look at it. Consequently, Lotus spent \$1 million in January and February, advertising 1-2-3 in *The Wall Street Journal*, *Business Week*, *Time*, *Newsweek*, and the computer press.

Still another move in the company's anti-VisiCorp blitz was the wooing of dealers. "We created a tutorial on disk—it's part of the package that the user buys—with an on-line 200-page Help facility," said Kapor. The tutorial was sent to dealers before the official release, both to help them familiarize themselves quickly with the package and to provide "a product that would require less support later on." Lotus has also run 1-day seminars for some 800 dealers to help them understand the product. The only problem now, Kapor says, is that he is under incredible pressure to come out with the software equivalent of the best-selling first-time author's second novel. "We better have the next miracle to ship," he added. "And, in fact, we do have some magic up our sleeves."

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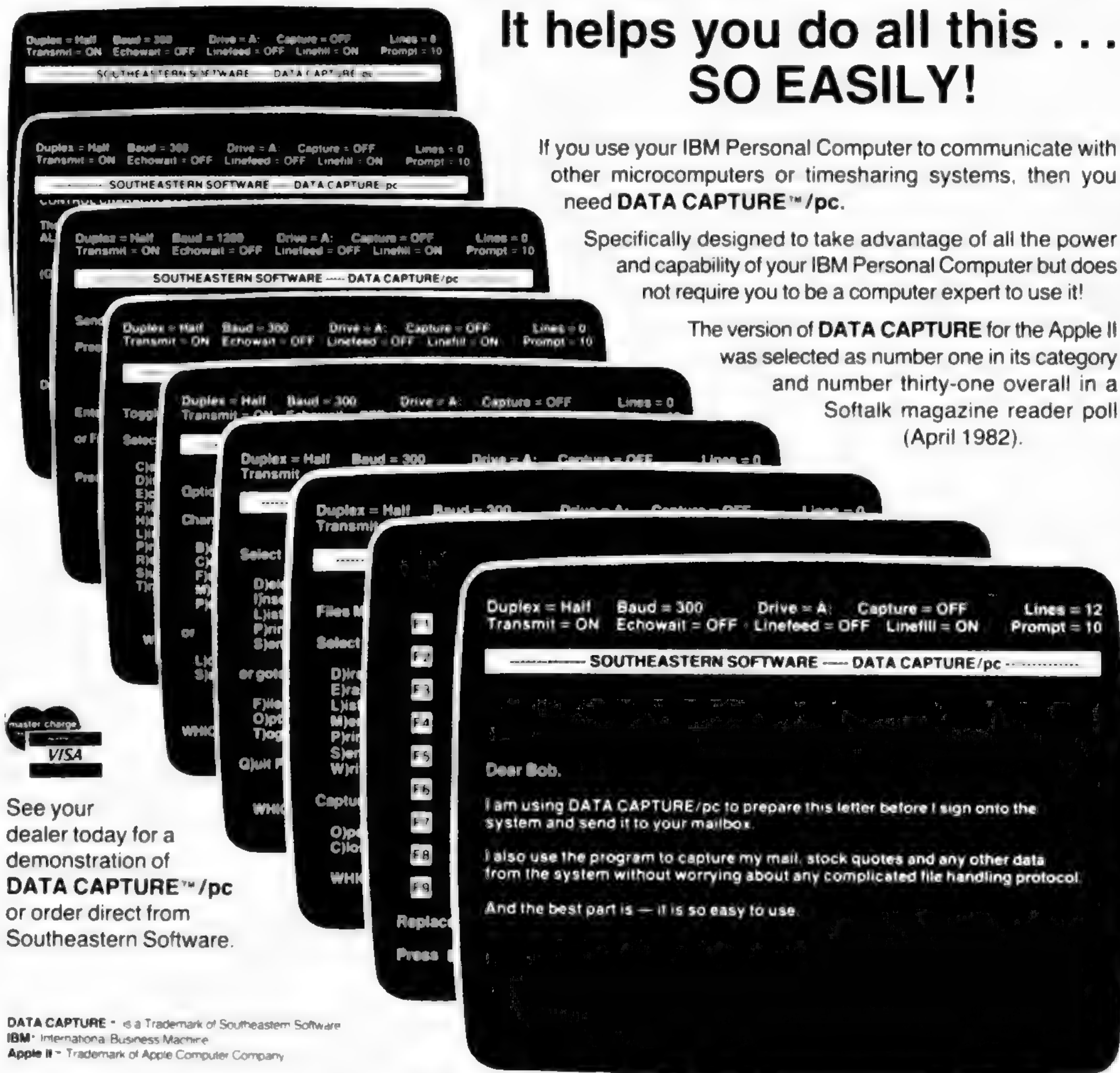
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# The Age Of Independence

The wealth of microcomputer software available today constitutes a library in excess of 40,000 programs of every conceivable type and quality. Surprisingly, most of the so-called "good" software has been developed by individuals working independently in their basements.

Whether the IBM PC operating system developed by Tim Patterson, CP/M developed by Gary Kildall, VisiCalc developed by Dan Bricklian, Microsoft BASIC developed by Paul Allen and Bill Gates, TMaker developed by Peter Roizen, Lattice C developed by Francis Lynch, or any of a long list of others, the quality of the independently produced programs is on a par with anything developed for micros by large corporations, and in most cases far superior.

## The Independent Edge

Why have large corporations failed to dominate this lucrative market? The answer is simple. Software development is largely a solitary effort. A decade ago the investment required for software development was approximately ten times greater than required today. This amounted to a nominal investment 10 years ago of perhaps \$20,000 to \$100,000 as compared to

\$2,000 to \$10,000 dollars for the necessary microcomputer systems today.

The advent of sophisticated hardware systems such as the IBM PC, languages such as Microsoft's BASIC Interpreter and BASIC compiler, the Lattice C compiler, and the myriad development tools—linkers, editors, and debuggers for microcomputers—allows the individual software developer to compete with the largest of the Fortune 1000 companies.

There is, however, even more compelling argument in favor of individual software development efforts. Most salaried programmers have a weekly paycheck to look forward to, plus an occasional, though rare, bonus. An individual, working independently, has much the same motivation as a wildcat oil man. Any oil he strikes is his own, and those wells keep right on pumping dollars. Similarly, entrepreneurial software developers can look forward to years of royalty checks for successful products.

Thus, a large corporation is typically in no better position to develop microcomputer software than is a skilled individual working independently. Furthermore, an individual is often prepared to gamble a man-year or more of his free time. A large

corporation can afford no such luxury.

### Software Marketing

Further, the marketing of software is a relatively new and undeveloped discipline. A number of software publishers have carried the burden of marketing the cottage industry products to dealers, dis-

tributors, end users, and original equipment manufacturers (OEMs). Currently the book publishers are scrambling to enter this field of publishing in an effort to boost revenues.

It is claimed that approximately 78 percent of all bookstore sales are to women between the ages of 20 and 45. Close to 10

percent of bookstore revenues are currently computer and computer-related books. Thus, the bookstores find themselves catering to only a segment of the potential market for the majority of their sales while the computer books are sold to a broad market. If book dealers can add software to their product offering, they can reasonably expect to sell to a much larger customer base. This software will probably range in suggested retail price from \$29.95 to \$495, with the majority of the sales being the lower-priced product. There is, however, little software designed for the lower end of this price range. This provides an excellent opportunity for the independent software developer.

As for the broader marketing of software, a number of software publishers are actively publishing the intellectual properties of this modern-day cottage industry. An author provides the program, some form of documentation, a sample of the source code, demonstration software, and illustrative examples. The publisher will typically typeset and package the documentation, provide technical support for the product to the end user, advertise the product, offer it for a wide variety of machines, distribute technical descriptions to potential customers, provide catalogs, and mail royalty checks to the author—all at no direct cost to the originator of the program.

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**O**NE MIGHT ask why hardware manufacturers don't actively develop software for their machines.

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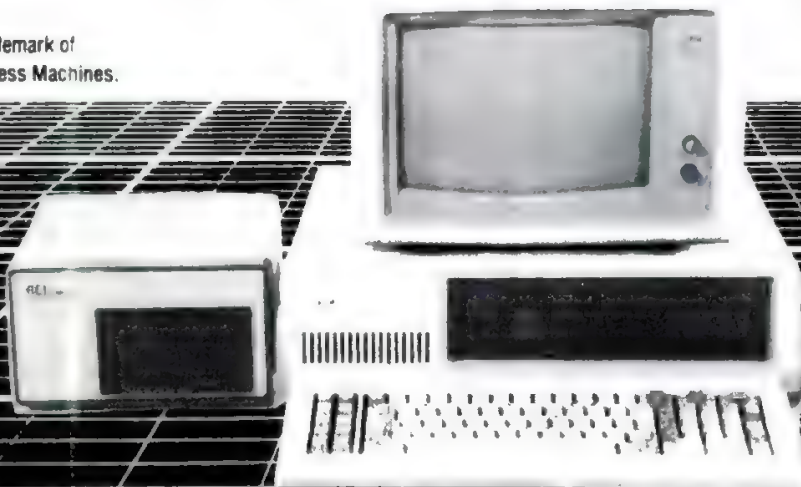
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together in an attractive and functional package. Thus, corporations producing microcomputers are little more than packaging and marketing operations.

Software, which is generally more sophisticated than its hardware counterpart, is not readily available as subassemblies or modules that can be configured to meet a particular requirement.

Software is complex technology even in its simplest form. No one would consider offering end users hardware that didn't function exactly as promised. On the other hand, there is a universal understanding that all software has "bugs." Furthermore, software is virtually impossible to debug comprehensively prior to its release. The independent software developer is able to compete with larger companies that might otherwise claim that their product is more thoroughly tested or better supported. However, most larger companies don't permit a programmer to maintain his connection with a particular product. Instead, they often assign him to other projects, sometimes unrelated. Consequently, cus-

tomers support can rarely rely directly on the developer.

In contrast, the independent software developer typically continues to work on

**T**HERE IS  
a universal  
understanding that all  
software has "bugs."

his product, offering an endless variety of enhancements, debugging strategies, and related products. He operates in an atmosphere devoid of bureaucratic budget constraints, company politics, unrealistic schedules, and changes in corporate direction and emphasis.

Furthermore, he usually enters into a contract with his publisher that requires, among other things, that he be available to

provide technical support, training, and occasionally sales support. He has the luxury of remaining actively involved with his product for years. And perhaps most important, he determines the features, functions, and benefits that his product or products will offer. He may not always be right in his decisions, but there is never any question as to who is in control of his product.

He is also able to choose the market that he wishes to address and the marketing organization that will best present his product to that market. For example, vertical packages, which are becoming of increasing importance in the developing software market, are usually best marketed by an organization able to provide an outside sales force. Horizontal packages, such as word processors, are best marketed through dealers, bookstores, and telemarketing.

Furthermore, he is able to choose the broadest hardware base for his product and does not have to pin all his hopes on the marketing success of one hardware

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manufacturer or another. In fact, the broad base of CP/M-80 and MS-DOS users effectively allows him to target all micros if he wishes.

The advent of good C compilers for micros is a particularly important development for the independent software developer. They allow particular applications to be compiled on a wide variety of current hardware. Equally important, they allow particular applications to be compiled on future generations of machines.

This means that an author can expect a significantly greater lifetime for his products than heretofore possible. Previously, programmers writing in languages such as assembler were faced with the horrendous task of extensive recoding in order to transport their programs to new generation hardware. Their only alternative was to write their programs in languages such as BASIC or Pascal for which target machine compilers and cross compilers did not always exist.

#### **Demand in Search of Supply**

There exists an incredible demand for a wide diversity of software, but as yet no one has been able to determine *a priori* what constitutes a winning product.

The market for 16-bit applications packages is desperately searching for programs. Most of the 16-bit programs currently available are little more than recast versions of 8-bit software. Unfortunately, many of the new features—the availability of screen graphics, large amounts of RAM, the 8087 arithmetic processor—offered by the IBM PC and its clones are not taken advantage of by the reincarnations.

***T***HE MARKET  
for 16-bit applications  
packages is desperately  
searching for programs.

Also, many of the machines targeted for the home market have virtually little or no software of any consequence. The Timex TI 99/4 and Commodore 64, for example, are both excellent targets for low end software that can be easily provided



by the independent software vendor.

The software market has many of the characteristics of a horse race. There are many entries, but few true winners. Yet

**T**HE software market has many of the characteristics of a horse race.

the stakes are high, the entry fee relatively low for the independent software developer, the opportunities for creativity and innovation virtually unlimited, the excitement unbridled... It is an industry with infinite growth potential, unlikely to be dominated by the large corporations—all of which affords the entrepreneur with a unique opportunity. There is no more exciting field of technology and certainly none that is so easy to enter when one considers the potential for high returns.

Those who would tell you that the future will be dominated by the large software vendors, that you can't compete with large marketing organizations, that an individual software developer can't compete effectively with large development groups, that the hardware manufacturers will provide all the software an end user needs should be categorically and summarily ignored.

Get into your basement, fire up your microcomputer, learn the C language, and start writing that program you've been thinking about. Find yourself a publisher that you feel comfortable with, one who addresses the market that you are interested in, and you will be well on your way to the most exciting and rewarding adventure of your life! The time to start is now. /PC

Eddie Currie is the president of Lifeboat Associates, the world's largest software publisher. In the mid-1970s, he was Chief Executive Vice President of Micro Instrumentation and Telementary Systems (MITS), the New Mexico company that introduced the first consumer microcomputer, the Altair.

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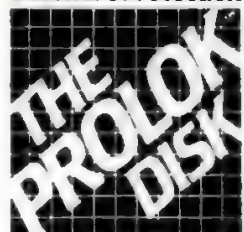
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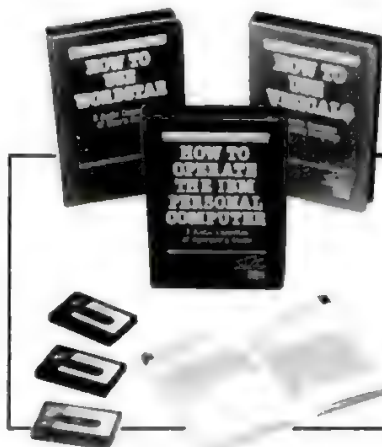
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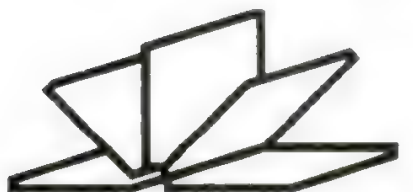
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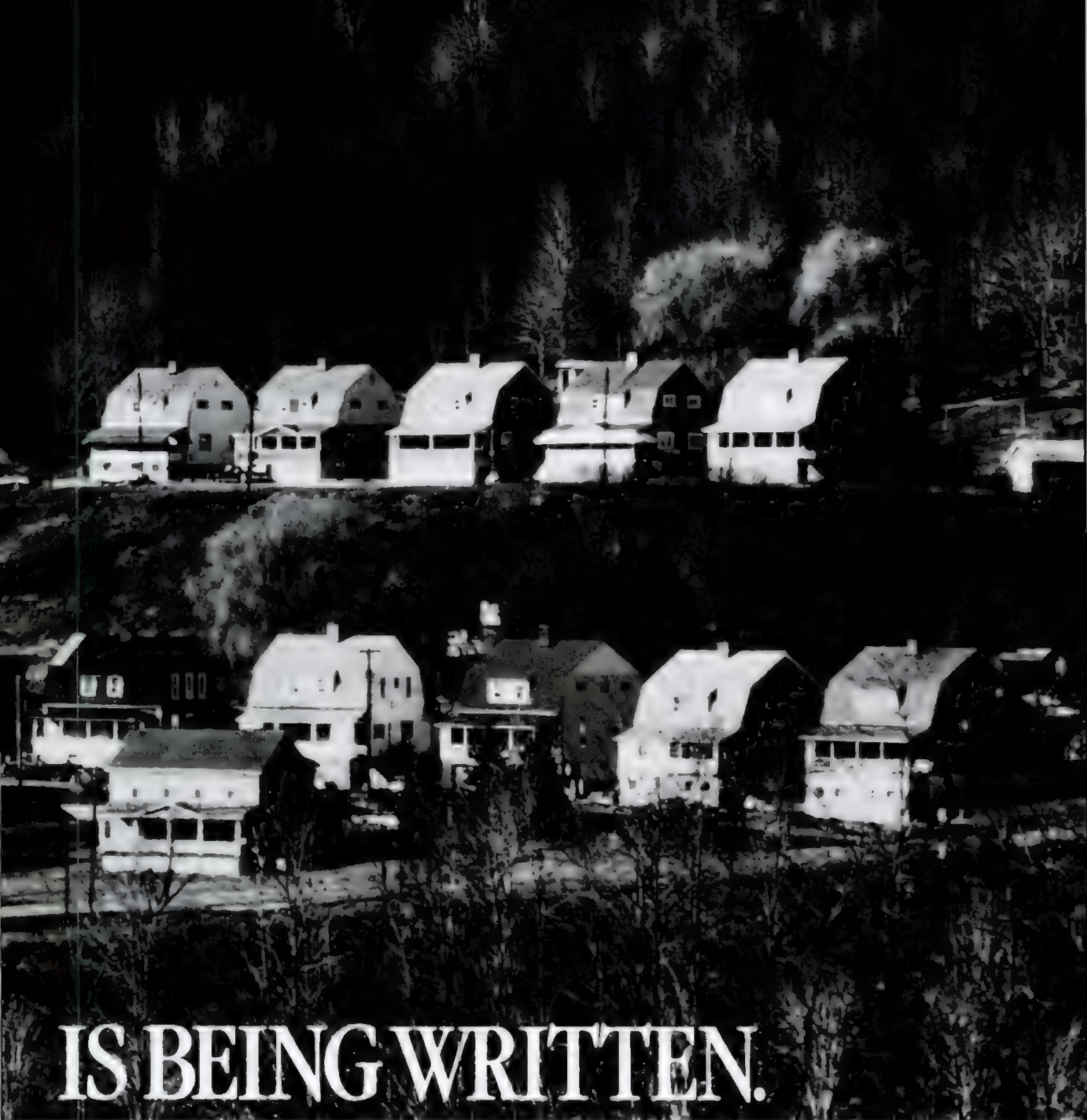
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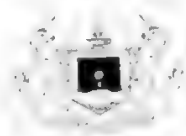
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*According to Joyce Wren, Director of Software Publishing in Boca Raton, IBM is actively soliciting program proposals from its own employees and from anyone else with a good idea.*

# Start Spreading The News . . .

On the wall of an executive office at IBM's Boca Raton, Florida complex hangs the needlepoint sampler that stars in a current television advertisement for the Personal Computer. It reads: "Hat of the Month Club."

Big Blue is not really entering the haberdashery business, but it surely has tossed its chapeau with gusto into the consumer market for the first time with a line of in-house and independently developed software and books. In fact, it had already shipped 16 titles by the beginning of July, with more in the pipeline. These products are in addition to the commissioned or acquired programs like PC-DOS, MultiPlan, PeachText, and other packages already cramming shelves in IBM-related stores.

"We know that when someone buys a PC, they're very likely to be back soon to the same place to pick up some software," said Joyce Wren, Director of Software Publishing for IBM's Entry Systems Division.

That is why the company has entered into the market, she says, and that is at the heart of the sales pitch IBM gives to prospective authors.

"We can bring the expertise we have in areas of testing, publications, and experience in how a user uses software. I hate to use the term 'user friendly,' but that is what we are talking about here," Wren said in an interview in Boca Raton recently. "We also have the manufacturing capability and distribution and marketing expertise."

And, in a roundabout way, Wren let it be known that she believes a software author can expect to earn more money if his or her work is encased in an IBM binder. She would not divulge details but did indicate that several individuals are near or past the \$100,000 royalty point in one or another of the various plans. (IBM, in the face of protests from authors, recently removed a "cap" on earnings that had been established at that level. There is



Joyce Wren, Director of Software Publishing for IBM's Entry Systems Division, in front of PC headquarters in Boca Raton.

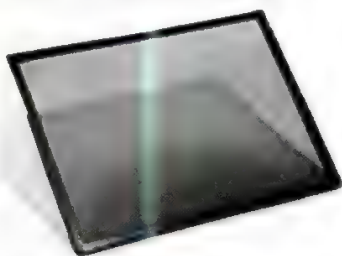
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### The Channels of Commerce

The software products are marketed through the same channels employed for the Personal Computer itself: IBM Product Centers and authorized dealers such as ComputerLand, Sears Business Systems Centers, and nonfranchised outlets.

IBM's official *Software Submissions Guide* states that the company "may establish other distribution channels in the future." Does this include non-IBM dealers? "Not today," Wren said. "We're looking at additional channels and a whole host of things relative to software, including faster distribution. We want our customers to be satisfied with the product. We want to be sure support can be offered."

"There is, though, the potential to offer entertainment software in a different manner," Wren said. How about mail order? "Probably not," she said.

### An IBM Old Hand

Wren has worked for IBM for the past 22 years, starting as a programmer at Advanced Systems Development in San Jose, California. She wrote software in assembler, hexadecimal, macroassembler, and a number of higher-level languages, entering into the management structure in 1965. She came to Boca Raton in January of 1982, as the *Software Submissions Program* was first getting underway.

**WE LOOK**  
*at our own employees  
as rich sources of  
submissions.*

On her desk is a PC-XT flanked by a full load of pastel-shade IBM software binders. She has a PC at home, which she uses to continue her office work and for word processing and financial modeling. She admitted to spending a fair amount of time recently playing with IBM's as-yet unreleased LOGO language. That product is

scheduled for introduction in the last quarter of this year.

There are three sources of material for IBM's software program: external, internal, and employee submissions.

"We look at our own employees as a rich source of submissions," Wren said. One reason is the "substantial" number of PCs purchased by employees through IBM's discount program.

Internal contributions are those written by IBM employees on company time, either specifically for the consumer market or developed for other uses. A pair of recent—and successful—examples are *Personal Editor* and *Professional Editor*. These products were developed at IBM's San Jose research site and were used extensively within the company before release. The product now on the stands is actually Version 5, Wren said.

Internal company authors do not receive royalties, but are eligible for special awards not directly tied to sales.

Employee submissions are those made by IBM personnel on their own time and with their own resources. Product Centers and other authorized IBM dealers have recently begun selling the employee-originated *Private Tutor*, a BASIC development system, as well as IBM's first book, an introduction to DOS 2.0.

Authors with no relation to IBM can sell a nonexclusive license with a negotiated royalty schedule based on wholesale revenues from sales. New products in this area include the *BASIC Primer* package. The external submissions run the whole gamut, from technical work to utilities to games.

IBM will continue to add to its store of software from a variety of sources, Wren said. In recent months, the company has added APL, an internal adaptation of an IBM-developed language, and the *Peach-Text* word processor, distributed under a license with Peachtree Software.

"We do go out and approach vendors as well," Wren said, "although we did that more in the beginning. We wanted to be sure there was certain software for the PC when it was introduced."

Included in those first offerings were one or two products—an un-easy word processor among them—that will not be forever cherished by IBM or early users.

"We found that people expect far more from a product with the IBM logo," Wren said, "even though the product when



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released was certainly equivalent to others on the market. We're learning, and that was a valuable lesson. We'll try not to repeat it."

**T**HE PC  
line will continue to be  
an open system.

Wren's department is the prime recipient of those user comment cards in the back of every piece of IBM software. There is a quality meeting every Monday at which measurable criteria on hardware and software are analyzed. According to Wren, many users' comments find their way into revisions or new products.

As with all other publishers and authors, Wren admitted to keeping a close watch on reviews of products. She likes to see both sides of any product described, not just the negative. "Don't expect us to be perfect. We try very hard for quality."

#### Openness Pays Off

Many observers say that one of the principal reasons behind the success of the PC has been IBM's choice of an "open" design—one that allows third-party software (and hardware) developers easy access. The company has published most of the details of its design in a series of technical reference manuals and has chosen to use as principal operating system a product that has been adopted by other manufacturers of hardware as a standard for machines built around the 8088 or 8086 microprocessor. This openness has led to the burgeoning market surrounding the PC (including PC Magazine) and to the continued sales success of IBM's micro-computer.

"The PC line will continue to be an open system," Wren said. "It seems to me that the more good software available, the more applications there will be and the more sales."

#### A Copy-protection Quandary

IBM and its authors are caught in the same uncertainty faced by other software companies in regard to the copy-protection question. Some of the company's releases are unprotected, like the DOS and

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language packages, while others are locked against ordinary copying schemes. Many of IBM's applications and games packages employ a third alternative, which allows a single copy to be made for archival purposes. IBM's introduction of a hard disk in its PC-XT and as an add-on to the PC complicated matters since a copy-

protected program cannot be run from a hard disk.

"Many authors and software vendors still want to protect their work," Wren said. "But we may be moving toward unprotection. Obviously it gives the user more flexibility if a product is not protected."

## The Guiding Byte: An IBM Sampler

*Big Blue's guidelines for software authors should be required reading for anyone thinking of writing a new program.*

The suggestions from IBM would probably serve as good advice for any would-be software author for the PC. Here are some samples:

**Program code:** Software should be structured in a "top-down" manner, with comments throughout. The remarks should be used to help in future maintenance and enhancement, referring to names of variables and their functions, diskette file formats, and references to internal ROM code.

**Copyrights:** Notices should appear in several places, including the first screen that appears, in memory whenever the program is running, within the first 20 lines when the program is printed, and on the external label of the diskette and packaging.

**Hardware dependency:** The program should be able to use both the monochrome display adapter and the color/graphics adapter and be able to check which adapter is installed in the PC being used. Device adapters (except for RS-232C ports) should not be initialized from within the program, avoiding dependence on the particular version or revision of the hardware involved.

**Follow IBM's rules:** The program should not include Calls to internal ROM routines (undocumented entry points or entry points currently pointed to by interrupt vectors). If you do so, the program is dependent upon a particular release of DOS or BASIC, a problem faced by a number of software developers when DOS 2.0 came along in March.

**Watch your colors:** All monitors do not support all colors, and certain color codes are unusable when displayed on a

monochrome monitor. Test your program on various combinations of monitors and display cards. Avoid unusual foreground/background color combinations. One of the two colors should be black or white. Overuse of color will undermine its effect and could lead to confusion.

**Some other hints:** Allow for recovery from error; display messages during times when the computer is making calculations or loading data; develop a consistent and orderly screen design; make consistent use of the function keys and the Escape key; in games allow sound to be shut off if desired.

IBM even has its own lexicon of recommended words. A few samples: Do use end, cancel, or stop; don't use abort. Do use enter; don't use return. Do use correct, good, or true; don't use valid.

**I**BM EVEN  
has its own lexicon of  
recommended words.

And finally, IBM has a section on writing manuals, discussing such often-ignored elements as tone (conversational recommended); voice (active: "when you operate the computer" is better than "when the computer is operated"); tense (present), and language (clear and concise and with an avoidance of unnecessary jargon, abbreviations, acronyms, and buzz words.)

—C.S.



# THE PC PROS

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## The Guide to Submissions

Entrance to the Software Submissions Plan is a two-step process. Wren's program publishes a 40-page booklet—packaged in the same vinyl-clad folder used for many of the software products sold by IBM. Included in the folder is a copy of an agreement and questionnaire that must be forwarded to IBM. You'll have to discuss

competitive products, the characteristics of the program and documentation that make it "friendly and easy to install and operate," and the hardware and software requirements of the program.

Authors are strongly urged to register their work with the U.S. Copyright Office before submission. IBM warns that even

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marketing may take from 3 to 6 months. According to the Plan, criteria include the following:

- Are installation instructions easy to locate and follow? Do they require the user to customize any hardware or software?
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- Does the product use sound, color, and graphics effectively?
- Does the program provide adequate feedback to the user?
- Do all of the functions in the program work? Are errors adequately prevented and detected?
- How does the product compare to potentially competitive products already on the market? Do comparable products offer more or less in function and price?

And the final question for IBM to answer: Does this product seem a likely source of profit? Each of these points is discussed at length in a section of guidelines.

### And the Winner Is . . .

Wren said she expects "productivity applications"—word processors, electronic spreadsheets, and the like—to continue to be popular, "until we find additional uses for the computer." On the horizon, she said, may be a truly user-friendly database, with a natural language interface and a dynamic structure that would allow the program to adapt to the user rather than the other way around.

"The uses that we can put a personal computer to are endless," Wren said. And IBM, no doubt, will be peddling its hats, madly.

/PC

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Gentlemen

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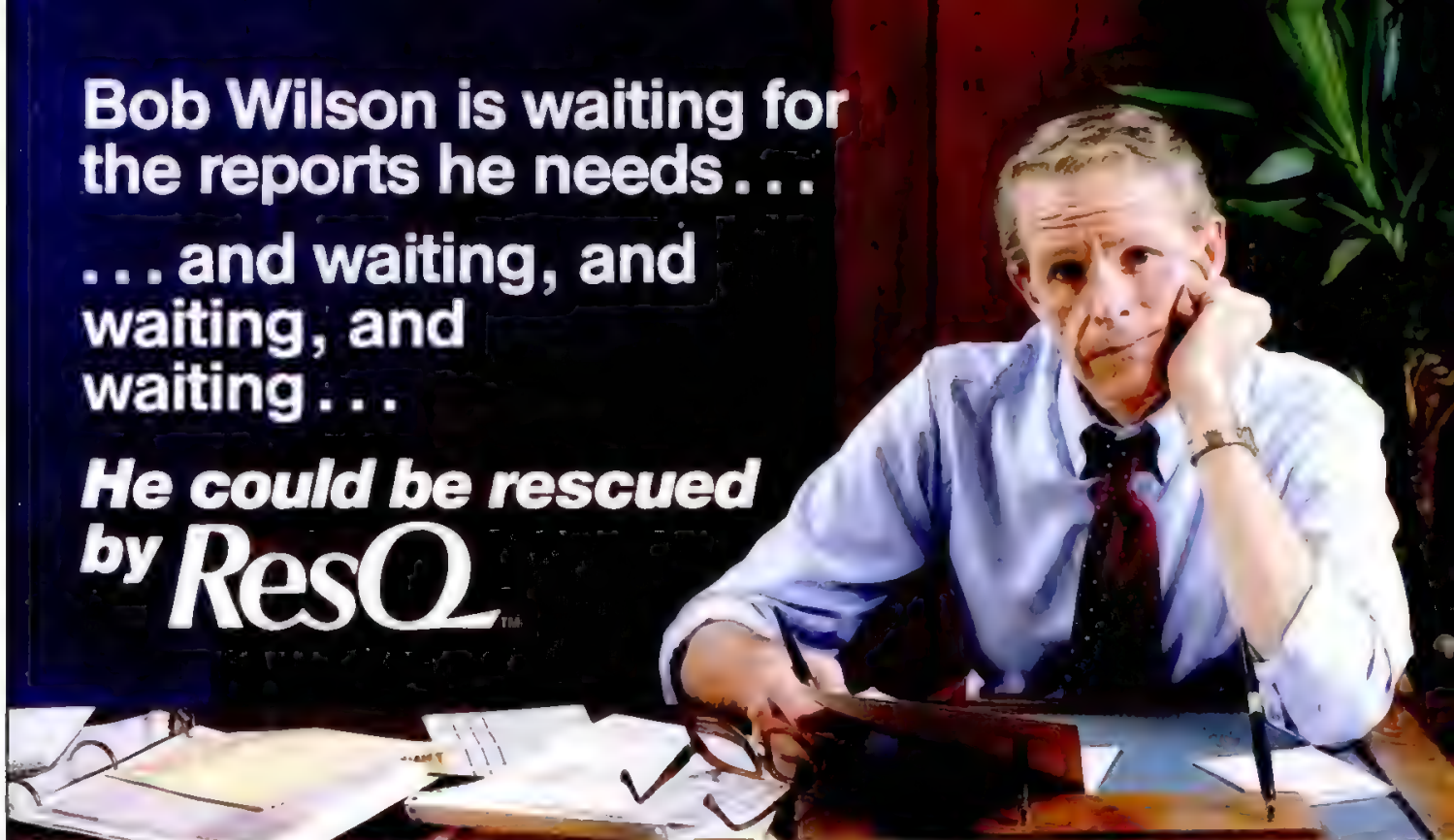
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*Publishers that have traditionally looked to mass-market and trade books as the money makers, are, with the help of increasingly aggressive agents, crowding into the computer book and software markets.*

# The Softening of Publisher's Row

For years, two of the nation's leading trade conventions—the American Book Association (ABA) and the Consumer Electronics Show (CES), coexisted on the calendar without conflict.

Last June, however, when the ABA met in Dallas and the CES powwowed in Chicago, the shuttle express was working overtime, as numerous software manufacturers, distributors, and a new breed known as software agents crossed the country's midsection enough times to confuse their Windy City how-you-do's and their Lone Star state howdy's. Interestingly, these faces were neophytes on both show floors. But while the electronics moguls had already made space for microprocessors between their audios and videos, the booksellers still needed to be convinced. They were in the midst of a massive sales pitch from the software companies and agents to convince them that the boom in computer book sales is but the first stage in the invasion of computerwares, which wants its share of shelf room between Jane Fonda and Garfield.

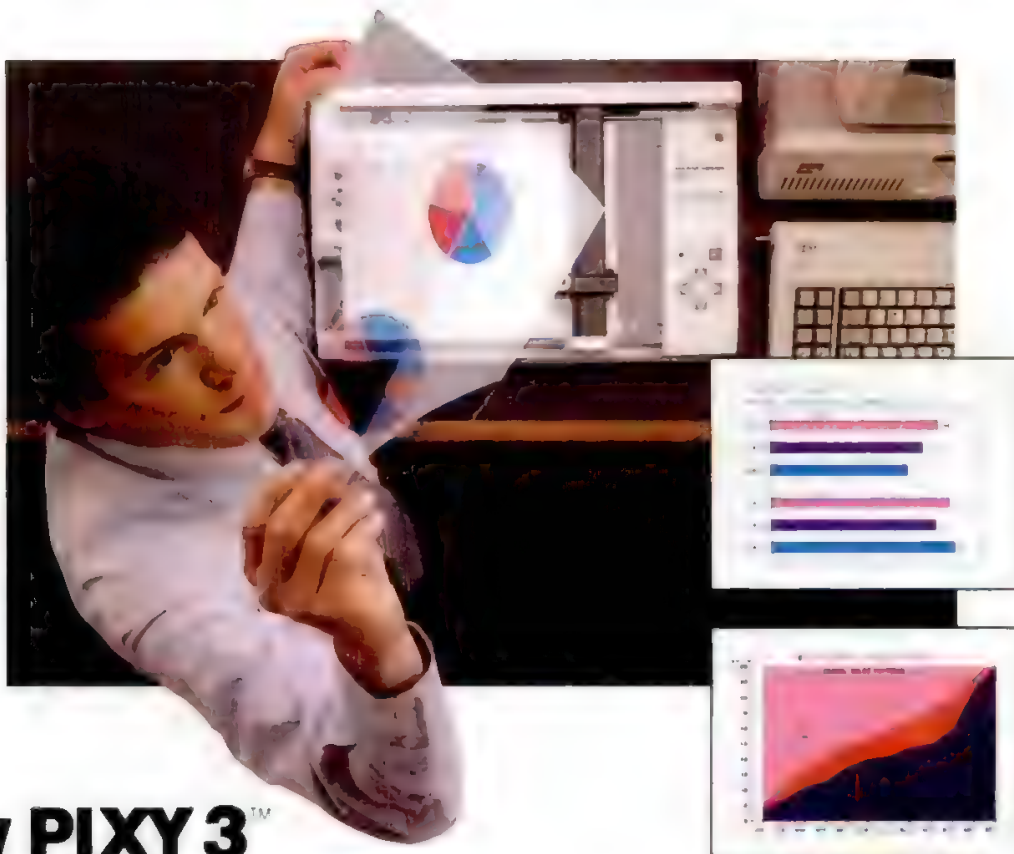
Twenty-three software publishers exhibited their goods at the ABA that month, while an avalanche of new computer titles pertaining to the various computers (even the unroasted Peanut) were spotted among the season's soon-to-be remaindered book jackets.

More than new faces and computer-related business cards were circulating on the ABA floor. Everyone was talking about the deals. To those who had knocked about the land of galley proofs and lunches at Elaine's for many years, the atmosphere was reminiscent of the 60s, when everyone seemed eager to read his way through the Nixon administration. The last 12 months had seen figures going to computer writers, both book and software, that had traditionally been reserved for names like Norman Mailer and Judith Krantz. Cases in point:

- Stewart Brand received \$1.3 million for an 8½-by-11 trade paperback (due Fall 1984) to be called the *Whole Earth Software Catalog*, patterned after the successful counter-cultural publishing venture of



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a similar name that Brand edited and published in 1968.

● Software publisher Bruce & James, creators of the Visionline computer programs, predict sales of up to \$100 million

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after forging an exclusive U.S./Canada distribution deal with Simon & Schuster. Simon & Schuster launched the product line with the WordVision word processing program for the IBM PC, listed at a tempting \$49.95. (Bruce & James is the combined effort of Bruce McLoughlin and Jim Edlin.)

● Harper & Row has reportedly advanced \$600,000 to InfoWorld magazine for the rights to a forthcoming book series. The books will be machine-specific and will be taken largely from the publication's "Software Report Card" review series. Meanwhile, Simon & Schuster, outbidding six other publishers, agreed to pay an \$800,000 guarantee for the PC World Reference Library.

● At press time, Kriya Systems, Inc. of Chicago, a software publisher noted for its Typing Tutor and Learning Lab educational titles, was peddling the rights to a package of its products to prominent book publishers for a figure reported as high as \$20 million in royalties. Company president Sat Tara Khalsa explained (apparently with a straight face): "It's certainly a good place to start." Meanwhile, Ted Leonsis, publisher of the semi-occasional software guide LIST, was in the process of ironing out contractual glitches in a six-figure, multi-book deal with Warner Software. New American Library (NAL)/Sig-

net was also about to add its name to the list of publishers that had passed the million dollar mark with a computer-book-related acquisition.

News like this has sent New York's publisher's row into a tizzy. Management is being shuffled to satisfy this new growth market. Simon & Schuster is predicting a \$5 billion-a-year bookware industry by 1985. Warner Books, E.P. Dutton, Simon & Schuster, MacMillan, Random House, NAL, and Harper & Row have all sectioned off special divisions devoted to computer book and software development. Pioneers in this field include Addison-Wesley, John Wiley, Prentice-Hall, McGraw-Hill, and Harcourt, Brace, Jovanovich.

There are reports that B. Dalton is selling more computer books than fiction in its nationwide chain, and that computer books account for fully 10 percent of Dalton's business. Although this claim was attributed to a B. Dalton executive, and is commonly quoted as proof that computers have finally made their mark in book-

stores, nobody there remembers saying it. "I suppose the quote is now generally believed," explained B. Dalton division manager Tim Higgins. "There would be no point to stand up and scream and deny it. It was an overstatement though. I can't say that the business accounts for 10 percent of our total sales. I can state, though, that it is the fastest growing category."

Still, computer book sales were significant enough that 6 months ago, the company began to publish a computer best-sellers list in its weekly in-house merchandise bulletin.

### Software Agents

Agents and agencies haven't been left out of the ruckus. Sterling Lord, William Morris, even Morton Janklow, who garnered \$3.2 million for Judith Krantz's Princess Daisy, have let loose the leashes on prime agents with a taste for \$100,000 commission checks, Saab Turbos, and homes in the likes of Sag Harbor.

Though it would be an exaggeration to trace all this activity to one office—on the

## What Kind of Software Are Publishers Looking For?

With all the sudden publicity about publisher acquisitions of software and computer books it might erroneously seem that this new outlet is a wide-open bonanza for the hacker population.

However, according to Jane Isay of Harper & Row, publishers are being more selective, and she offers some insight into what she and her peers are looking for.

"Immediately, the IBM PC fits into my publishing plans for everything but the games and educational software. I don't at the moment think that the PC is widely enough available in the home—for the kids—to make it worthwhile converting the educational and game software to the PC. But I'm watching it very closely. If they do come out with the Peanut, then it's going to be a different ballgame."

"The software we are looking at has to be designed so that the computer is a tool of the user, and that the user is not some kind of slave, having to stick her nose in the documentation all the time to figure out what to do next. I require clarity of design, so that the command structure of

any software I publish has a logic that doesn't require memorizing lots of things—that it's clear. I require a certain quality of screen display: there's an aesthetic, or developing aesthetic, of screen display. In addition, I feel very strongly that the only software that Harper & Row should publish is software that does things uniquely suitable for the computer. I get very irritable when I see software that is nothing but a workbook on the screen."

Does it pay to commission an agent to deal with the publishers? Isay replies that since the big dollar publicity has hit the industry, numerous new and uneducated agents have been pitching computer-related deals. "I find myself irritated beyond words when an agent calls and says, 'I have this thing. I don't understand it. But why don't you just give it a look.' I recently spoke to the Literary Agent Association and said that having an agent as the pocket of ignorance between the programmer and the publisher is harmful and crazy."

—M.P.



west side of Manhattan at that—it might at least be a good starting point to look at the Broadway address of John Brockman Associates, a literary agency that boasts a dual logo of winglike book leaves and the magnetic Cyclops known as the floppy disk.

John Brockman made all the aforementioned deals—landed some mighty big marlins, as the Hemingway literati might

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## **M**AKING *deals for small independent software publishers is like going out for blue fish when the tuna are running.*

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put it. In just a few months, he accumulated close to \$3 million in advances for a handful of clients. The sum in itself is staggering, but it becomes even more so when you realize who, exactly, John Brockman is.

Brockman's reputation on the row is as a serious nonfiction agent for such esoteric clients as Allan Watts, John Lilly, Gregory Bateson, Paul Krasser, and one concession to the low brow and lustful porno celebrity, Seka. His business apparently revolves around the Palo Alto/Berkeley axis, which bloomed intellectually in the 60s, and, though out of fashion, is still knocking around. Knocking around in the San Francisco Bay Area inevitably leads to Silicon Valley, which helped supply a nation's craving for prunes and apricots years before it manufactured a single microchip.

"I had been building a very successful business," Brockman recalled recently during a week when he was auctioning off yet another six-figure computer book deal. (By the way, most of these auctions never make it to the slap of a hammer since the Fortune 500 companies prefer preempting the bids to avoid the escalatory back-and-forth haggle.) "About a year ago last April I figured it was time to get a computer for the office. I started going through what everybody goes through, which is reading everything and realizing that there was

very little software available."

Brockman never bought the computer, though he is currently eyeing the IBM XT. He did change his company's logo, however. He had a realization: "First, there were going to be 25 million computer owners by 1985. Each of them will buy between eight and ten computer books and \$1000 worth of software. More important though, from my point of view, was that everyone who buys a computer is also a potential author of software. There was no such thing as a software agent."

Like many agents who are now entering the computer business, Brockman at first aimed his efforts at the mom and pop software writers who had set up mail order businesses in their living rooms with an occasional expansion downstairs to the finished basement. He soon recognized bigger game. Making deals for small independent software publishers, at least at this stage of the book/computer connection, is like going out for blue fish when

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## **T**HE BOOK *industry could be very receptive to an alternate source of income and revenue.*

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the tuna are running.

Brockman earned his first commission 7 months later when he signed his first contract for client Bruce & James. President Jim Edlin explained, "I had a conviction that it was the right time to mass market personal computer programs. A mass-market approach involved making the programs easy to understand and comfortable to work with. The price also had to be right but this mass market orientation could eliminate the ridiculous prices that, up until now, have prevailed in personal computer software."

"It seemed to me that bookstores have three areas of compatibility that make a lot of sense. The product is physically compatible with the kind of merchandise they handle. That is, we could make it be about the same size and shape and make it look the same as the things they were already

doing. It was conceptually compatible with what bookstores already did, anyway. In other words, it's not that far away from being a self-help book or reference book—that is, if it is priced right."

As an afterthought (though its significance shouldn't be slighted), Edlin added, "Besides, these days the book industry has its problems. Therefore, it's an industry that could be very receptive to an alternate source of income and revenue."

You would think so, wouldn't you? But there was and still is resistance. Many of the industry's aristocrats appear uncomfortable with publishing electronics instead of the almighty written word. Even after the Association of American Publishers unanimously voted to accept software makers into its ranks, high-level brass with leading imprints continued to snub their noses at the new industry. Martin P. Levin, president of Times Mirror Books told a New York Times reporter, "I think it's a fad like hula hoops." Thomas McCormack of St. Martin's Press was quoted as adding, "There's bound to be an unpleasant shakeout." Still other book publishers have officially ignored the new trend, though their mercenaries are scurrying around the country beating on microchip bushes as if they were Christmas trees.

Edlin and Brockman's sales job initially fell on deaf ears. They refined their pitch, gathered more ammunition, and even educated a publisher or two along the way. Brockman explained what tipped

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## **S**UDDENLY, *every writer who had ever touched a computer keyboard was pitching book deals.*

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the balance: "I think the most important thing, from our point of view, was the Time magazine cover with the computer as 'Man of the Year.' The same week NBC ran a network special on the micro. And then there was the overall gestalt of the thing; people were realizing that this is not a fad, that it's like the next industrial



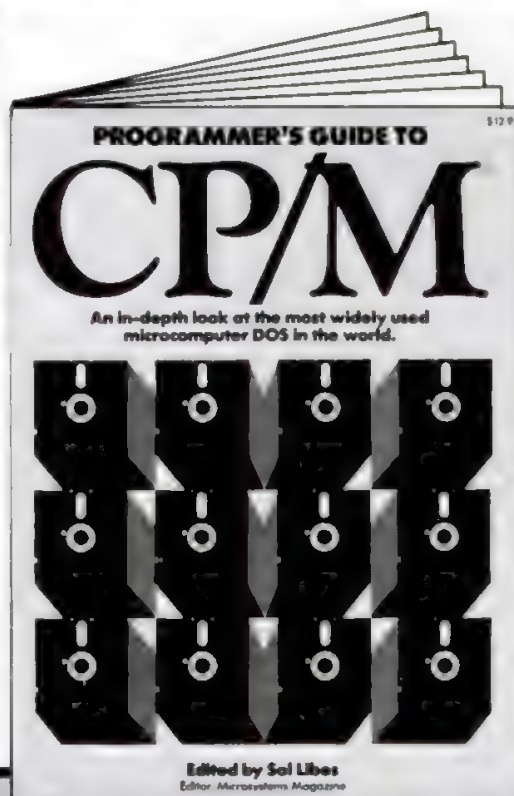
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revolution: Either you get into it or risk the consequences of running a railroad when everybody travels by plane."

Obviously the sales pitch worked. Simon & Schuster was receptive and also eager to move, since it promoted industry veteran Al Reuban to the presidency of a new division with computer books and

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**I**F THE market is as big as it seems to be, then a million dollars will be nothing to let everybody know that you're the first person in it.

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software under its wing. The company agreed that a product with a price point below \$50 could fit into the bookstore environment without requiring demonstration, selling, or hand-holding. Besides, software sales in bookstores was not an unknown quantity. B. Dalton had been experimenting with software sales in select bookstores (mostly around Washington D.C.) for several years, having mixed, though encouraging, results. On the other side, the book business had been eyeing the network of computer stores as possible outlets to augment their mass market distribution, which was already extensive.

If any one thing softened the acceptance of software in publishing circles, though, it was the fact that computer books were selling. The development was being called the most significant trend in the industry. Suddenly, every writer who had ever touched a computer keyboard was pitching book deals. The media were bandying about an unattributed "fact" that computer buyers selected three (sometimes five, depending on who was quoting) book titles before making their computer format plunge. Meanwhile, companies like Addison-Wesley, which had been selling computer books for years, were suddenly making a fortune on properties that had only cost them \$10,000. The Ingram Book Company reported that

## The Computer Press Association

*A professional group formed to monitor the computer publishing business.*

In response to the increasing market for words about computers—for documentation, magazine articles, and books—the Computer Press Association (CPA) was formed at last May's National Computer Convention (NCC) held in Anaheim, California.

According to its organizer Barbara Elman, a total of 350 writers to date have expressed interest in a professional group that will monitor the computer publishing business, give referrals, address writer legal issues, and keep tabs on publishers that don't pay their bills. Dues range from \$35 for an individual to \$100 for a corporation. Already, anthologies of writings by CPA members have been negotiated with major book houses.

For information contact: Barbara Elman at Word Processing News, 211 E. Olive, #210, Burbank, CA 91501, telephone: (213) 845-7809 or 854-4161.

—M.P.

its computer book sales rose from \$184,000 in 1981 to \$1.8 million in 1983. With the leverage of mass market heavyweights from the book business, it was believed the entire computerware market would skyrocket.

### Million Dollar Books

Along with such predictions came the inflated prices. \$1.3 million was the price that did it. During each publishing year there is one figure that remains set in every book person's mind. \$1.3 million identified 1983 since it was the price that Doubleday paid to preempt a John Brockman auction of the U.S./Canada rights to a forthcoming computer revival of Stewart Brand's laid-back *Whole Earth Catalog* best-seller, based on a 12-page outline.

Brockman commented, "I think Doubleday was after two things. First, they were making a statement that they were in the business. Second, I don't think they would have made such a statement unless they thought they could profit from the deal. I think they will show a profit very

easily. I think if we went to auction it would have gone for more money."

Added Jay Acton, a principal in the Software Agency, a computer merger of the Sanford Greenburger and Moulter agencies, "In many ways, on Doubleday's part, it was a brilliant move because it announced to everybody that they were a serious player in this thing. If the market is as big as it seems to be, then a million dollars will be nothing to let everybody know that you're the first person in it."

Those are the words of agents who are obviously biased; they receive 15 percent of every penny they pitch successfully to a publisher. On the book side of things, the publishers are cringing. Jane Isay, who was recently transferred from Harper & Row's Basic Books, to head its new electronic publishing division related, "I think prices like these are going to destroy the market. If you look at the profitability of trade publishing and the number of mass market houses that have closed

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**T**HERE is basically no difference between the obsessive tripping that goes on with drugs or with computers. They're both called users.

---

down in the last 5 years, you will see that the big bucks are a large cause of it.

"I think you will see each major publisher doing one of these deals, and then scurrying around madly to pick up the two-to-five-to-ten-to-twenty-thousand dollar books, the way they used to. A big figure does two things: It makes a statement and also commits a company to create the marketing to get the money back—thus creating a market."

But Jane Isay and Harper & Row made a deal: They paid the \$600,000 guarantee to InfoWorld for rights to its forthcoming book series. The division's first software product, a \$100 word processing program for the Apple, is due in the stores this month.

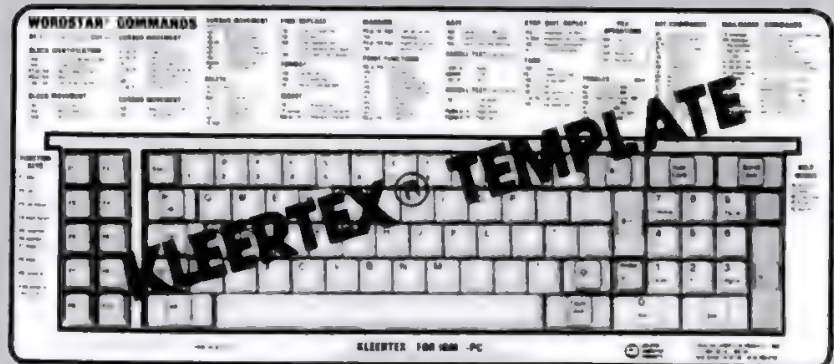


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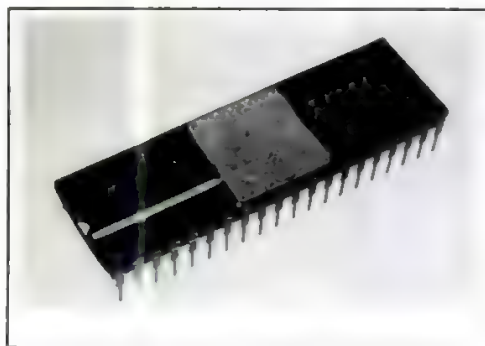
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On the computer end of the business there was some question about the Stewart Brand deal as well, though the publicity brought micro celebrities to Brockman's doors with dollar signs in their eyes. Ted Leonsis, publisher of LIST, was drawn to the agent by the publicity (as well as Brockman's common request: "Ever

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## ***THE publishing guys are starting to feel there's a little life in the industry again for the first time in years.***

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thought of writing a book?), and as a result, appears at press time to have signed a lucrative deal with Warner Software for a series of machine format books that contain a mail order sampler of software.

"You can quote me on this, okay?" Leonsis offered. "Who is Stewart Brand to command \$1.3 million for software evaluations? Okay? One, straight software evaluation outside of a real world environment is not useful. Two, from a pure business standpoint they have to sell about half a million books to break even."

Call the critiques of Brand and Brockman's gold mine premature, microsnobbery, or envy, the fact remains that the unorthodox Brand, who, with his *Whole Earth Catalog*, created the independent publishing business and possibly the entire do-it-yourself book market, has set his sights on the computer. And, Brand is no micro-newcomer, either. He has worked for several years with a Kaypro portable, included ten pages on computers in his *Next Whole Earth Catalog*, and began investigating microprocessors with an article on Alan Kay and Xerox Park for *Rolling Stone* in 1972.

"Both the 60s and computers are about the same things," Brand explained. "The hackers, when I first wrote about them in 1972, were clearly all heads. Not all heads, however, were hackers. Now, rapidly, all heads are becoming hackers. There is basi-

cally no difference between the obsessive tripping that goes on with drugs or with computers. They're both called users."

As with the *Whole Earth Catalog*, Brand and his research team, headed by editor Art Kleiner, will begin with a series of periodicals, titled the *Whole Earth Software Review*, which will be compiled in the book, *Whole Earth Software Catalog* in Fall 1984. The 200-page book will be produced by Brand's nonprofit Point Foundation. The catalog will include input from software users, who will be encouraged to submit hands-on evaluations of all varieties of software and hardware for publication. In a sense, like its precursor that introduced everything from kerosene heaters to midwifery for the masses, the *Whole Earth Software Catalog* will be user-written as well as user-friendly. As part of the contract with Doubleday, there is only a 6-week turnaround scheduled between the day the publication boards

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## ***WITH computers, something new is happening every second.***

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are delivered and the day the book is in the stores. The aim was to keep the catalog as up-to-date as possible, a Houdini-like task in an industry long dominated by quick-change artists.

"The book is going to change the publishing business in many ways. One is by shaking up the cartel of inertia that has run the business for so long," Brand explained. "It usually takes 18 months to get a book out. There's no excuse for that. It is really punishing to the authors and readers as well."

Research for the *Whole Earth Software Catalog* has already begun. The Point foundation team has begun its solicitations of user groups throughout the country. The group itself is armed with a work force of Kaypros, though they are soliciting hardware gratis from a variety of manufacturers. IBM already turned them down. Brand admits the team will be

forced to purchase a PC, though he shows some lingering preference for the Compaq. The catalog, meanwhile, has grown from strictly software to hardware reviews as well, for "one-stop shopping," as Brand intoned.

"The major thing I see happening, though, is that the publishing guys are starting to feel there's a little life in the industry again for the first time in years," he added. "The price we received might have frightened some people, but it seems to have cheered up everyone that publishing is finally climbing back on its feet."

Others agree that a state of enthusiasm is raging down publisher's row. Jay Acton related, "It's like outfitting the world with dictionaries all over again." However he cautioned, "The book business better get its act together on this thing. The software business has grown pretty far without the publishers to this point."

The proof of the publishers' gambles won't be seen for 2 years yet. However, the sudden publicity an outsider like John Brockman has generated in traditional publishing circles has left an impression that book people won't easily forget.

"Nobody puts a gun to a publisher's head," Brockman said. "We don't say the price is so and so. We submit the material to a number of publishers, we create a market situation, and they pay what they want to pay. A book or software deal is worth only what somebody wants to pay for it."

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## ***IT'S like outfitting the world with dictionaries all over again.***

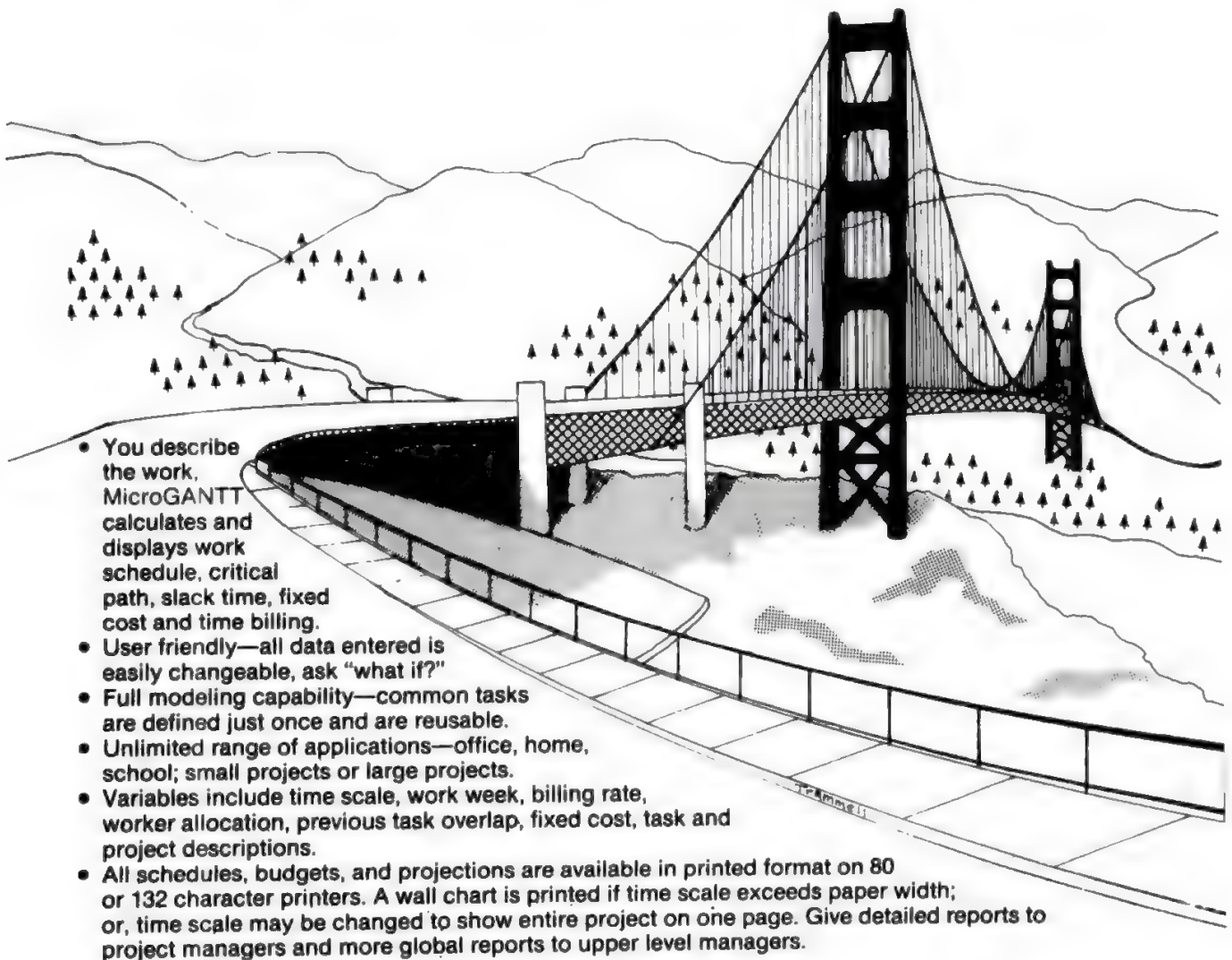
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"Otherwise the publishing business is very moribund," he added. "I see what's happening. I know what's happening. And what's happening is very little. With computers, something new is happening every second. It's more of a challenge. You have to adjust. The microcomputer software business isn't just publishing—it's a regular wild west show." /PC

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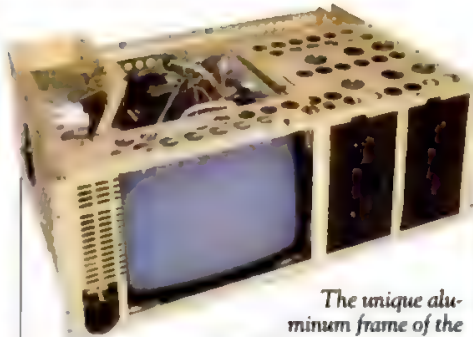
What's more productive than a computer? A computer that works for you in more places.

### Works with the greatest number of programs

The most important consideration when you choose a computer is "what programs will it run?" And that's one more reason for choosing the COMPAQ Portable.

The COMPAQ Portable runs more programs

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*The unique aluminum frame of the COMPAQ Portable has cross-members that strengthen it front-to-back, side-to-side, and top-to-bottom. It's a design practice commonly used in race cars.*

than any other portable. In fact, it runs more than most non-portables. That's because it runs all the popular programs written for the IBM<sup>®</sup> Personal Computer. There are hundreds of them. They are available in computer stores all over the country, and they run without any modification, right off the shelf.

Imagine the power of a portable word processor. There are dozens of different word processing programs available for the COMPAQ Portable.

Planning, problem-solving, and "what-ifs" are a cinch with a variety of popular electronic spreadsheet programs. The COMPAQ Portable runs them all.

There are accounting programs for anything from computerizing your family budget to full-scale professional management of payables, receivables, inventory, and payroll for your company.

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So, you get portability and you don't give

up problem-solving power. The combination adds up to the most useful personal computer on the market today.

### Works better because it's easy to read

The display screen of the COMPAQ Portable measures nine inches diagonally. It shows a full "page width" of 80 characters on a line so tasks like word processing are easier. And those characters are big enough to read even if you're leaning back in your chair.

The display shows both high-resolution graphics and easy-to-read, upper- and lowercase characters. One screen



*There are hundreds of useful programs for the COMPAQ Portable because it runs all the popular programs written for the IBM.*

for all the information. With some personal computers, including the IBM, you can have either the graphics or the legible characters, but you can't have both unless you buy two different displays.

Incidentally, computer prices are often quoted without a display. The display of the COMPAQ Portable is built in, of course.

### Add-on options make it work the way you work

Inside the COMPAQ Portable are three open slots. Electronic devices called expansion boards fit those slots and give the COMPAQ Portable new powers.





Just like the programs, expansion boards designed for the IBM work with the COMPAQ Portable, so there are dozens available right now. With them, you can make your personal computer more personal.

Want to check a stock price? Or look up something in The New York Times Information Service? One expansion board enables the COMPAQ Portable to handle those communications over ordinary phone lines.

Want to use your company's central computer files while you're on a trip? There are boards that allow the COMPAQ Portable to communicate with a variety of large mainframe computers.

Other boards let you hook up controllers for computer games or increase memory capacity. Still others let you connect personal computers in a network so several people in your office can share the same information.



*Inside the COMPAQ Portable are three slots for optional electronics that can add new capabilities. Most portables have none.*

### **Works better because it's tough enough for the road**

Portable doesn't just mean smaller. Portable means tough, too.

The COMPAQ Portable was built to withstand the hard knocks of constant travel. An aluminum frame within the case completely surrounds the computer's working components. Each disk drive is mounted in rubber shock absorbers instead of being bolted directly to the frame.

To test internal components, the COMPAQ Portable was subjected to impacts of 40 G's while running a program. After impacts on each side, there was no internal damage and the program was still running. Without error.

Computers are for getting rid of worries, not giving you new ones.

### **Designed to help you work better, too**

The COMPAQ Portable was designed to feel good.

## **Specifications**

### **Software**

- ☐ Runs all the popular programs written for the IBM PC

### **Memory**

- ☐ 128K bytes RAM
- ☐ Expandable to 640K bytes

### **Storage**

- ☐ One 320K-byte minifloppy disk drive, second drive optional

### **Display**

- ☐ 9-inch (diagonal) monochrome screen
- ☐ 25 lines by 80 characters
- ☐ Upper- and lowercase, high-resolution text characters
- ☐ High-resolution graphics

### **Expansion board slots**

- ☐ Three IBM PC-compatible slots

### **Interfaces**

- ☐ Parallel printer interface
- ☐ RGB color monitor interface
- ☐ Composite video monitor interface
- ☐ TV RF modulator interface
- ☐ Communications interface optional

### **Physical specifications**

- ☐ Totally self-contained and portable
- ☐ 20"W x 8 1/2"H x 16"D

The keyboard is detached so it can fit into your most comfortable working position.

The keyboard cable remains connected at all times. So you don't have to unpack it and hook it up every time you use your computer.

Because the display is built in, the COMPAQ Portable makes a neat,

small package on your desk, instead of a big obstacle you have to talk around. The built-in display also avoids the usual cable clutter because there's no need for separate cables for the display.

The COMPAQ Portable even has an electronically synthesized sound to create the familiar keyclick of a typewriter. With a simple keyboard command you can adjust the volume to suit the level of background noise in your office.

### **The added usefulness is free**

The COMPAQ Portable can do what desktop computers do and do it in more places. But it doesn't cost any more than an ordinary desktop.

In fact, it costs hundreds less than a comparably equipped IBM or Apple® III. The COMPAQ Portable comes standard with one disk drive and 128K bytes of memory, both of which are usually extra-cost options. A second disk drive and additional memory are available to make your COMPAQ Portable even more powerful.

The bottom line is this—you just can't buy a more practical, useful, productive computer. Before you decide on a computer, you owe it to yourself to compare the COMPAQ Portable.

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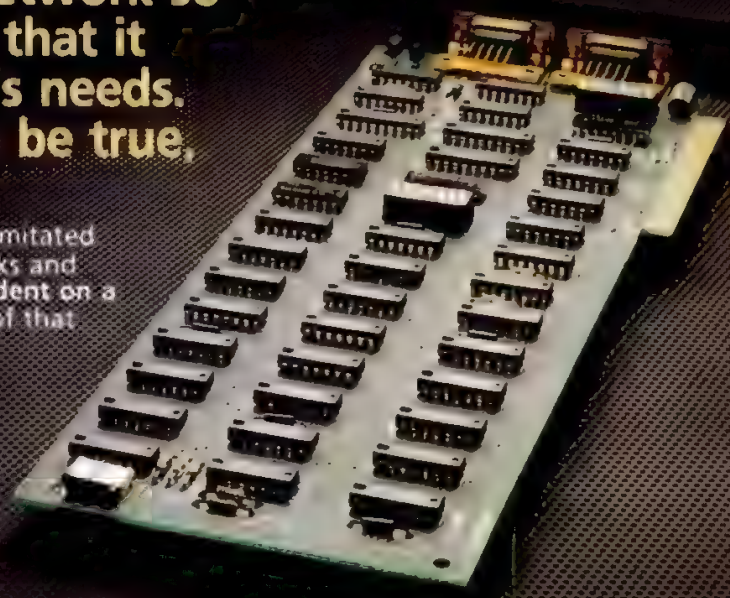
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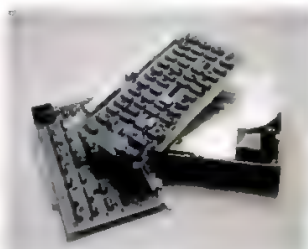
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*"The father of the IBM System/360" hands down advice on getting the bugs out of, not only a piece of software, but the team that creates it as well.*

# THE MYTHICAL MAN-MONTH

In 1964 Frederick Brooks became manager of the team developing the operating system (OS/360) for IBM's System 360, the mainframe computer that was the standard for the industry from the mid-1960s to the early-1970s—the longest reign of any system in the history of computing. Before he was put in charge of the OS/360 software, Brooks had been project manager for the hardware architecture of the System/360.

In the preface to his book, Brooks summed up these projects: "Managing OS/360 development was a very educational experience, albeit a very frustrating one. The team, including F. M. Trapnell who succeeded me as manager, has much to be proud of. The system contains many excellencies in design and execution, and it has been successful in achieving widespread use. . . . It is now quite reliable, reasonably efficient, and very versatile.

"The effort cannot be called wholly successful, however. Any OS/360 user is quickly aware of how much better it should be. The flaws in design and execution pervade



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especially the control program, as distinguished from the language compilers. Most of these flaws date from the 1964-1965 design period and hence must be laid to my charge. Furthermore, the product was late; it took more memory than planned; the costs were several times the estimate; and it did not perform very well until several releases after the first."

Before taking charge of the OS/360 project, Brooks had arranged to leave IBM to teach at the University of North Carolina beginning in 1965. In the following years, Brooks analyzed his experiences with development at IBM and wrote essays that attempted to answer the question of why software development projects are so hard to manage.

Ten years after leaving IBM, Brooks compiled his conclusions on programming and management in a book—*The Mythical Man-Month*. In the decade since this book appeared, which has seen the emergence and rise of the microcomputer field, the hard-won lessons of common sense that Brooks provided have endured as pertinent advice for software developers as well as managers in any industry.

Frederick Brooks is now Kenan Professor and chairman of the computer sciences department of the University of North Carolina at Chapel Hill. He is preparing a major work on computer architecture in collaboration with Jerry Blau.

## The Tar Pit

Een schip op het strand is een baken in zee.  
[A ship on the beach is a lighthouse to the sea.]

—DUTCH PROVERB

No scene from prehistory is quite so vivid as that of the mortal struggles of great beasts in the tar pits. In the mind's eye one sees dinosaurs, mammoths, and sabertoothed tigers struggling against the grip of the tar. The fiercer the struggle, the more entangling the tar, and no beast is so strong or so skillful but that he ultimately sinks.

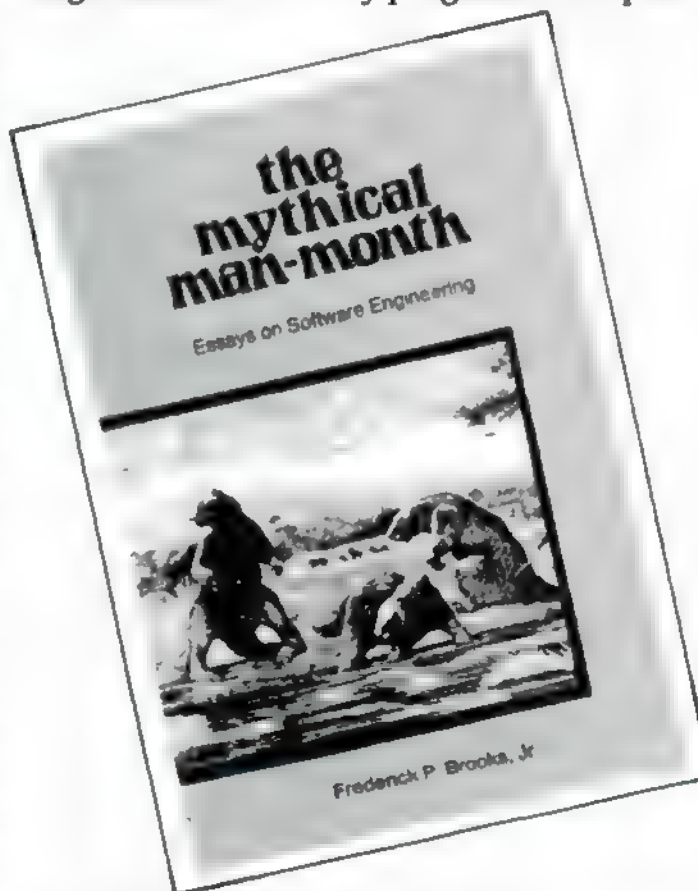
Large-system programming has over the past decade been such a tar pit, and many great and powerful beasts have thrashed violently in it. Most have emerged with running systems—few have met goals, schedules, and budgets. Large and small, massive or wiry, team after team has become entangled in the tar. No one thing seems to cause the difficulty—any particular paw can be pulled away. But the accumulation of simultaneous and interacting factors brings slower and slower motion. Everyone seems to have been surprised by the stickiness of the problem, and it is hard to discern the nature of it. But we must try to understand it if we are to solve it.

Therefore let us begin by identifying the craft of system programming and the joys and woes inherent in it.

### The Programming Systems Product

One occasionally reads newspaper ac-

counts of how two programmers in a remodeled garage have built an important program that surpasses the best efforts of large teams. And every programmer is pre-



*The Mythical Man-Month:*

*Essays on Software Engineering*

Frederick P. Brooks, Jr.

Copyright 1975 by Addison-Wesley Publishing Company, Inc., Reading, Massachusetts; 195 pages;  
ISBN 0-201-00650-2

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pared to believe such tales, for he knows that he could build any program much faster than the 1000 statements/year reported for industrial teams.

Why then have not all industrial programming teams been replaced by dedicated garage duos? One must look at what is being produced.

In the upper left of Figure 1 is a program. It is complete in itself, ready to be run by the author on the system on which it was developed. That is the thing commonly produced in garages, and that is the object the individual programmer uses in estimating productivity.

There are two ways a program can be converted into a more useful, but more costly, object. These two ways are represented by the boundaries in the diagram.

Moving down across the horizontal boundary, a program becomes a programming product. This is a program that can be run, tested, repaired, and extended by anybody. It is usable in many operating environments, for many sets of data. To become a generally usable programming product, a program must be written in a generalized fashion. In particular the range and form of inputs must be generalized as much as the basic algorithm will reasonably allow. Then the program must be thoroughly tested, so that it can be depended upon. This means that a substantial bank of test cases, exploring the input range and probing its boundaries, must be prepared, run, and recorded. Finally, promotion of a program to a programming product requires its thorough documentation, so that anyone may use it, fix it, and extend it. As a rule of thumb, I estimate that a programming product costs at least three times as much as a debugged program with the same function.

Moving across the vertical boundary, a program becomes a component in a programming system. This is a collection of interacting programs, coordinated in function and disciplined in format, so that the assemblage constitutes an entire facility for large tasks. To become a programming system component, a program must be written so that every input and output conforms in syntax and semantics with

Frederick P. Brooks, Jr., *The Mythical Man-Month*, © 1975, Addison-Wesley, Reading, Massachusetts. Reprinted with permission.



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precisely defined interfaces. The program must also be designed so that it uses only a prescribed budget of resources—memory space, input-output devices, computer time. Finally, the program must be tested

**A**S A RULE of thumb, I estimate that a programming product costs at least three times as much as a debugged program with the same function.

with other system components, in all expected combinations. This testing must be extensive, for the number of cases grows combinatorially. It is time-consuming, for subtle bugs arise from unexpected interactions of debugged components. A programming system component costs at least three times as much as a stand-alone program of the same function. The cost may be greater if the system has many components.

In the lower right-hand corner of Figure 1 stands the programming systems product. This differs from the simple program in all of the above ways. It costs nine times as much. But it is the truly useful object, the intended product of most system programming efforts.

### The Joys of the Craft

Why is programming fun? What delights may its practitioner expect as his reward?

First is the sheer joy of making things. As the child delights in his mud pie, so the adult enjoys building things, especially things of his own design. I think this delight must be an image of God's delight in making things, a delight shown in the things that are useful to other people. Deep within, we want others to use our work and to find it helpful. In this respect the programming system is not essentially different from the child's first clay pencil holder "for Daddy's office."

Third is the fascination of fashioning

complex puzzle-like objects of interlocking moving parts and watching them work in subtle cycles, playing out the consequences of principles built in from the beginning. The programmed computer has all the fascination of the pinball machine or the jukebox mechanism, carried to the ultimate.

Fourth is the joy of always learning, which springs from the nonrepeating nature of the task. In one way or another the problem is ever new, and its solver learns something: sometimes practical, sometimes theoretical, and sometimes both.

Finally, there is the delight of working in such a tractable medium. The programmer, like the poet, works only slightly removed from pure thought-stuff. He builds his castles in the air, from air, creating by exertion of the imagination. Few media of creation are so flexible, so easy to polish and rework, so readily capable of realizing grand conceptual structures. (As we shall see later, this very tractability has its own problems.)

Yet the program construct, unlike the

poet's words, is real in the sense that it moves and works, producing visible outputs separate from the construct itself. It prints results, draws pictures, produces sounds, moves arms. The magic of myth and legend has come true in our time. One types the correct incantation on a keyboard, and a display screen comes to life, showing things that never were nor could be.

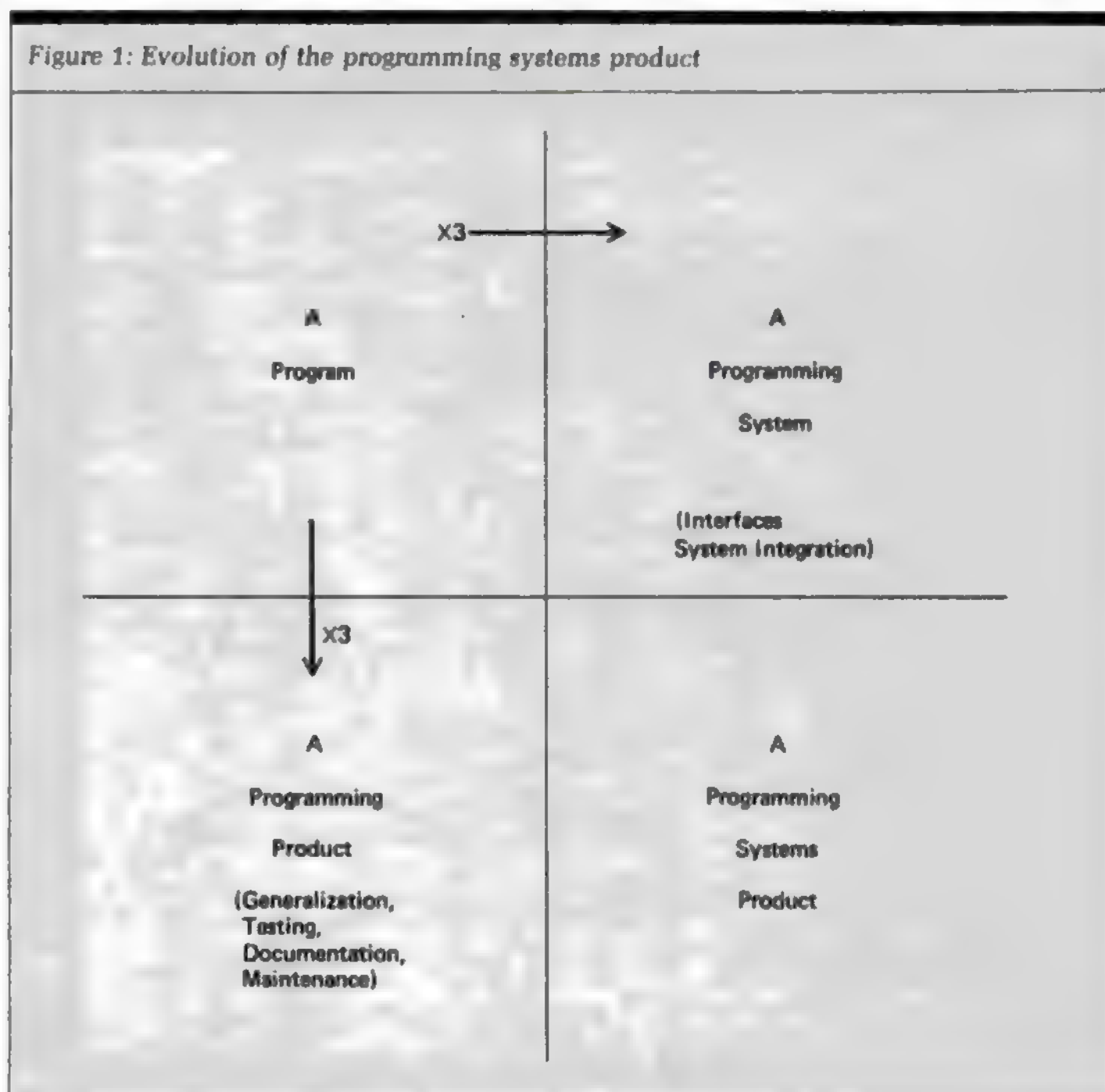
Programming then is fun because it gratifies creative longings built deep within us and delights sensibilities we have in common with all men.

### The Woes of the Craft

Not all is delight, however, and knowing the inherent woes makes it easier to bear them when they appear.

First, one must perform perfectly. The computer resembles the magic of legend in this respect, too. If one character, one pause, of the incantation is not strictly in proper form, the magic doesn't work. Human beings are not accustomed to being perfect, and few areas of human activity demand it. Adjusting to the

Figure 1: Evolution of the programming systems product





# Straight talk about printers

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## Dot Matrix Printers

Since an IBM PC can drive almost any parallel printer on the market, software compatibility is critical. Remember, too, that no printer is 100% compatible with the PC except the PC printer—Epson, Gemini, Okidata & Mannesmann Tally printers are the next best things.

## EPSON

### FX, RX & MX



The **FX-80** features 180 cps, a correspondence font & a new body (tractor is optional), in addition to all the features normally found on the old **MX Series**, which is being phased out. (The **FX-100** is the 136 column version).

The **RX Series**, which replaces the **MX**, offers 100 cps print speeds, but nothing more remarkable. Call for the latest version & the best prices.

## C. ITOH

### Prowriter



C. Itoh has produced a winner. The **Prowriter** has speed (120 cps), a buffer (1.5K), 10, 12, & 16 cpi (plus a correspondence font) and graphics (160x144 dpi). It's the printer of choice for several major OEMs. The **Prowriter 2** has the same specs, but in a 132 column format. Popularity is may be its only curse: the **Prowriter** can sometimes be hard to keep in stock.

Prowriter ..... \$399.88  
Prowriter 2 ..... \$719.88

## STAR MICRONICS

### Gemini 10X/15

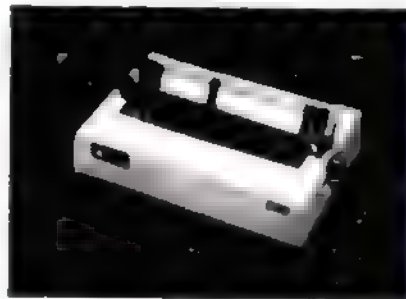


**Gemini 10X** is a new release of an old favorite. The 120 cps is the big change. They dropped the pro-

portional font, but kept the correspondence font. The 120x144 dpi, 5 fonts (w/italics) & 1K buffer are standard. **Gemini's** comes with tractors & uses plain spool ribbons. The **Gemini 15** is the 132 column version, & it has the correspondence font. Call for the latest & greatest in prices.

## OKIDATA

### Microline Series



We use these printers in our offices. The **Microline 82A** (80 col) & **83A** (132 col) are data crunchers, with two interfaces (parallel or RS-232C), 120 cps, 10 & 16 cpi (w/double-width) & optional dot-addressable graphics.

The **Microline 92** (80 col) & **93** (132 col) are ideal for word processing. They offer a 180 cps draft mode, a 40 cps correspondence mode & the dot-addressable graphics are included.

The **Microline 84** (132 col) combines speed (200 cps) with 10, 12, 16 cpi (w/double-width), all with a correspondence mode, plus dot addressable graphics.

Microline 82A ..... \$419.88  
Microline 83A ..... \$679.88  
92/82A Tractor ..... \$59.88  
82A/83A ROM ..... \$49.88  
Microline 92 ..... \$524.88  
Microline 93 ..... \$884.88  
Microline 84 ..... \$1024.88

## MANNESMANN TALLY

### MT-160 L



The **MT-160 L** is the newest of the correspondence quality printers. It has speed (160 cps), 8 fonts (including a correspondence font), parallel & serial interfaces, friction/tractor feed, plus a menu-driven installation for easy set-up from the control panel—no more digging around for dip switches. It's remarkably compact & efficient, & the print quality is superior. This year's sleeper. The **MT-180 L** is the 136 column version.

MT-160 L ..... \$689.88  
MT-180 L ..... \$CALL

We sell other dot matrix printers, including the **Anadex WP-8000**, **DP-9501**, **DP-9620** & **DP-9625** & **IDS's Prism 80**, **Prism 132** & **MicroPrism**. You can call (800) 881-8855 for technical details. For prices, or to order, call (800) 343-0728.

## Letter-Quality Printers

Letter-quality printers are business machines, & very high-ticket ones at that. Most individuals should buy a dot matrix first, adding letter-quality when it's needed.

## C. ITOH

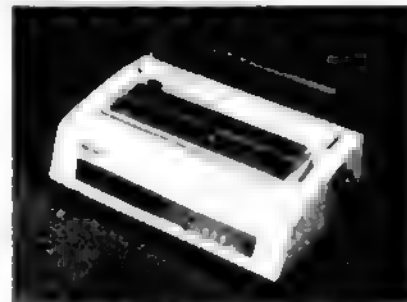
### Starwriter



The **Starwriter**, released last year by C. Itoh, has proven a worthy printer. You don't trade-off speed for price or quality. The **Starwriter** uses Diablo code, wheels & ribbons, has a 40 cps print speed, 1/48" line space, 1/120" horizontal spacing—ideal for proportional modes. (For real speed freaks, there's the **Printmaster**, at 55 cps. Same specs as above.)  
Starwriter Parallel ..... \$1219.88  
Printmaster Parallel ..... \$1679.88

## DATA TERMINALS & COMMUNICATIONS

### DTC 380Z



The **380Z** is a letter-quality printer that rivals and replaces the Daisywriter 2000. It has the 48K buffer, true Diablo emulation & uses the Brother/Daisywriter supplies. The documentation is great, & the **380Z** even has pin-outs on the back for easy interfacing (parallel or RS-232C). Eat your heart out Daisy!  
DTC 380Z (Parallel) ..... \$1119.88

## SILVER REED

### EXP-550



Why buy a Transtar when you can buy from the guys who make them? The **Silver Reed EXP-550** is a 16 cps, 132 column letter-quality printer with true Diablo emulation, making it compatible with most word processing software. It's ideal for medium duty office work. Add a buffer & you'll have a versatile printing system. If speed's not a factor, the **EXP-500** at 12 cps (80 col) is available as well.  
EXP-550 (Parallel) ..... \$719.88  
EXP-500 (Parallel) ..... \$459.88

## SMITH-CORONA

### TP-1



The **TP-1** is an ideal second printer for small offices or homes. The tractor

feed (now available) enhances its paper handling. If you're letter-quality needs are light, this might be the machine. (Specify 10 or 12 cpi when you order.)

TP-1 ..... \$CALL  
TP-2 ..... \$CALL

We sell a variety of other letter-quality printers, including the **Comrex ComRiter**, **Diablo 820 & 830**, the **NEC 3530**, **3550 & 7730**, the **Qume 11+** & many others. Call (800) 881-8855 for technical details. For prices, or to order, call (800) 343-0728.

## Accessories

## QUADRAM

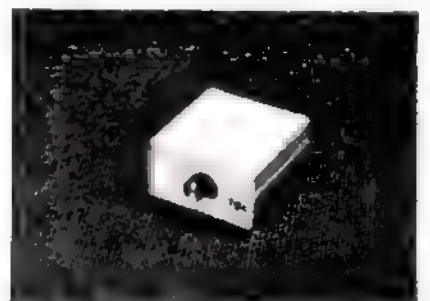
### Microfazer



Quadram's **Microfazer** is a stand-alone buffer that can be expanded to 512K—that's about 200 pages. External buffers can be moved from system to system, & they leave your PC memory free. The copy feature lets you print unlimited copies of a document. Comes with its own cable. The power supply is optional.  
8K parallel/parallel ..... \$154.88  
64K parallel/parallel ..... \$219.88  
256K parallel/parallel ..... \$629.88  
512K parallel/parallel ..... \$979.88  
9 Volt Power Supply ..... \$19.88

## TBL PRODUCTS

### Printer Switch



We finally found a printer switch box that we like. Switch between two printers, in parallel/parallel or serial/serial versions (all female plugs).  
2-Way Printer Switch ..... \$119.88

## UNIVERSAL OUTPUT SUPPLY

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Our pin-fed fanfold paper is 20lb white bond, shipped in a sturdy case. There are two sizes: 9 1/4" & 14 1/4". The wider paper also comes in green-bar.  
Paper (9 1/4") ..... \$44.88  
Paper (14 1/4") ..... \$49.88

## LEADING EDGE

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We use these disks in the office. The **Elephant Memory Systems 5 1/4" Diskettes** come 10 to the box. We also carry the "trunks" (read disk boxes), which hold 60 diskettes. 8" disks & trunks are also available.  
5 1/4" Double-Sided, Double-density (IBM PC Compatible) ..... \$32.88  
5 1/4" SSDD ..... \$27.88  
5 1/4" Trunks ..... \$24.88

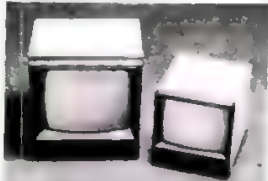


## Monitors

Most people know by now that IBM's monochrome monitor doesn't do graphics. If you need them, consider getting the Color/Graphics Card. The card & monitor cost less than the monochrome outfit. Add a Quad-board & you're in business.

USI

## Pi Series



Our love affair with the Pi 3 amber monitor continues. The consensus is yes, amber is easier on the eyes in the long run. So is the Pi-3's 20MHz bandwidth and sharp, clear phosphor. Comes in 9 or 12", & in green. Pi-2 (12" green)..... \$189.88 Pi-3 (12" green)..... \$189.88 Pi-4 (9" amber)..... \$189.88

## QUADRAM

### QuadChrome

The QuadChrome is one of the highest resolution RGBs available. 16 colors (using NEC's tube), 690 dots by 240 lines (480 non-interlaced), 15MHz bandwidth & more. The case is identical to IBM's, & it comes with its own cable. PGS HX-12..... \$529.88

## PRINCETON GRAPHICS

### HX-12

The HX-12 has the same spec's as the QuadChrome. Same price too. HX-12..... \$529.88

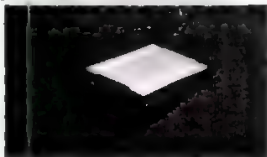
We also carry Amdak 300Q, 300A, Color 1, 2 & 3, the Electrohome 1302-1 & 1302-2 & Tayan's RGB-I, RGB-III, Green & Amber monitors. Call (603) 881-9855 for technical details. To order, call (600) 343-0726.

## Modems

Internal? External? 300 baud? 1200? Only you can answer these questions. 1200 baud makes sense if you're on-line during the day. If you're at home, on-line late at night, 300 baud may be all you need. As always, research this stuff before you buy.

## DC HAYES

### Smartmodem



The Smartmodem is an originate/answer, auto dial/answer, full/half duplex modem. It comes in two versions: 0-300 baud or 0-300/1200 baud. Modular phone cable & power supply included. The RS-232C cable is optional. Smartmodem (300 baud).... \$219.88 Smartmodem (1200 baud).... \$339.88

## US Robotics Password

**\$379.88 UPS DELIVERED**



An exceptional value for a 1200 baud modem. The Password is a direct connect originate/answer type modem with 0-300 & 1200 baud capability (Bell 212A compatible). Features include auto dial, auto answer, auto mode and auto speed select, full & half duplex (local echo), DTR override, RS-232C pins 2 & 3 reversible & audio phone line monitor. Single button operation makes the Password very easy to use. Comes with an RS-232C cable, power supply & modular telephone cable.

We also carry the Novation Series, including the Smart Cat 1200 & 300 & the US Robotics Auto Dial 212A. Call (603) 881-9855 for technical details/specs. To order, call (600) 343-0726.

## STANDARD MICROSYSTEMS

### M-Term

M-Term is both communications software & a terminal package. Certified 2400 baud operation, terminal/command mode, repeat DOS command & direct file transfer. It supports the auto dial/answer features of the USR Password, the DC Hayes Smartmodems & Novation's SmartCat. M-Term..... \$79.88

## Peripherals

There are endless peripheral boards available, most of them copies or variations on the "quad" function board. There's also a lot of misinformation regarding peripheral boards & the IBM PC-XT. Fac is, most peripheral boards work on the XT out of the box—you don't need to upgrade the motherboard or alter it. Read your documentation carefully & watch out for "experts" in stores.

## AST RESEARCH

### Megaplus

The Megaplus packs an RS-232C ports, a parallel port, a clock & up to 256K RAM into only one slot. Comes with SuperDrive/Spooler software. You can add memory in 64K units up to 256K. Megapak is a 256K piggy-back card, giving you up to 512K on one board. 64K Megaplus..... \$359.88 256K Megaplus..... \$509.88 256K Megapak..... \$329.88

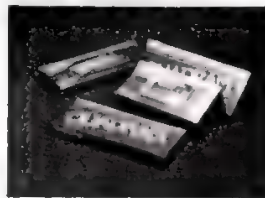
## I/O+

The I/O+ has a parallel port, two RS-232C ports, a game port & a clock, but no memory. I/O+..... \$199.88 Connect All..... \$24.88



## QUADRAM

### Quadboards



We sell Quadboards because they consistently perform better than the competition. Quadram's one-year warranty, & an ongoing R&D into new products (see QuadLink) demonstrates their commitment to the PC marketplace.

Quadboards have a RS-232C port, a parallel port, a clock & memory, plus QuadSpool/Drive software. Quadboard 64K..... \$279.88 Quadboard 256K..... \$429.88

Quad 512+ have a single RS-232C port on them, and sockets for up to 512K RAM. QuadSpool/Drive software included. Quad 512+ (64K)..... \$239.88 Quad 512+ (256K)..... \$399.88 Quad 512+ (512K)..... \$599.88

Single Function Cards are single-duty cards only, as described below. Parallel Card w/cable..... \$89.88 RS-232C Card..... \$89.88 Clock/Calendar Card..... \$89.88

## QUADRAM

### QuadLink

This is a real breakthrough! QuadLink lets you run Apple II/III+ software on the PC. It's like an Apple computer on one board, with 64K. Uses all PC printer/video ports. No disk conversion or reformatting required. Takes up only one slot. QuadLink..... \$549.88

## Disk Drives

Internal hard disk drives have one weakness: they can bring your whole system down if you have a problem. We suggest keeping the PC drives A & B intact, and using an external unit that can be detached should it need service.

Likewise, it's smart, if you're in a heavy production environment, to buy a floppy drive as a back-up to either drive A or B. The \$280 is cheap insurance against failure, & you can rotate them like tires to reduce mechanical wear.

## QUALITY COMPUTER SERVICES

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## IBM PC COMPATIBLE

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Sorry, we cannot accept open POs or extend credit/terms at these prices. APO and foreign orders are not accepted.

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requirement for perfection is, I think, the most difficult part of learning to program.<sup>1</sup>

Next, other people set one's objectives, provide one's resources, and furnish one's information. One rarely controls the circumstances of his work, or

## THIS BOOK will attempt to lay some boardwalks across the tar.

even its goal. In management terms, one's authority is not sufficient for his responsibility. It seems that in all fields, however, the jobs where things get done never have formal authority commensurate with responsibility. In practice, actual (as opposed to formal) authority is acquired from the very momentum of accomplishment.

The dependence upon others has a particular case that is especially painful for the system programmer. He depends upon other people's programs. These are often maldesigned, poorly implemented, incompletely delivered (no source code or test cases), and poorly documented. So he must spend hours studying and fixing things that in an ideal world would be complete, available, and usable.

The next woe is that designing grand concepts is fun; finding nitty little bugs is just work. With any creative activity come dreary hours of tedious, painstaking labor, and programming is no exception.

Next, one finds that debugging has a linear convergence, or worse, where one somehow expects a quadratic sort of approach to the end. So testing drags on and on, the last difficult bugs taking more time to find than the first.

The last woe, and sometimes the last straw, is that the product over which one has labored so long appears to be obsolete upon (or before) completion. Already colleagues and competitors are in hot pursuit of new and better ideas. Already the displacement of one's thought-child is not only conceived, but

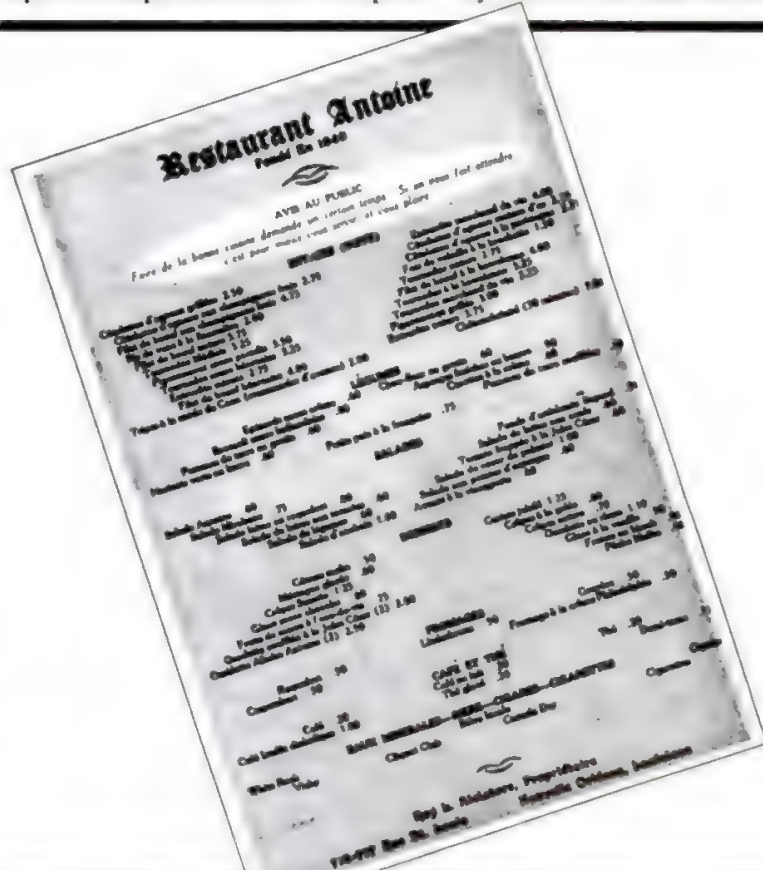
scheduled.

This always seems worse than it really is. The new and better product is generally not available when one completes his own; it is only talked about. It, too, will require months of development. The real tiger is never a match for the paper one, unless actual use is wanted. Then the virtues of reality have a satisfaction all their own.

Of course the technological base on which one builds is always advancing. As soon as one freezes a design, it becomes obsolete in terms of its concepts. But implementation of real prod-

ucts demands phasing and quantizing. The obsolescence of an implementation must be measured against other existing implementations, not against unrealized concepts. The challenge and the mission are to find real solutions to real problems on actual schedules with available resources.

This then is programming, both a tar pit in which many efforts have floundered and a creative activity with joys and woes all its own. For many, the joys far outweigh the woes, and for them the remainder of this book will attempt to lay some boardwalks across the tar.



## The Mythical Man-Month

Good cooking takes time. If you are made to wait, it is to serve you better, and to please you.

—MENU OF RESTAURANT ANTOINE, NEW ORLEANS

More software projects have gone awry for lack of calendar time than for all other causes combined. Why is this cause of disaster so common?

First, our techniques of estimating are poorly developed. More seriously, they

reflect an unvoiced assumption which is quite untrue, i.e., that all will go well.

Second, our estimating techniques fallaciously confuse effort with progress, hiding the assumption that men and months are interchangeable.

Third, because we are uncertain of our



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Figure 2: Time versus number of workers—perfectly partitionable task

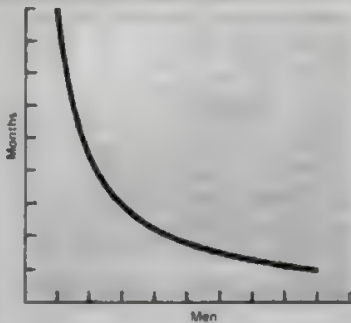


Figure 3: Time versus number of workers—unpartitionable task

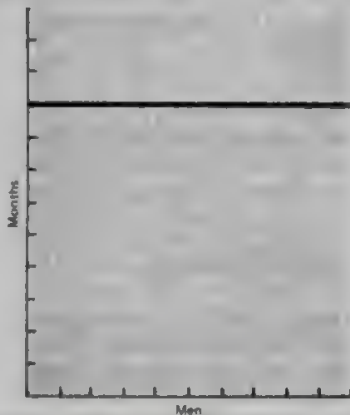


Figure 4: Time versus number of workers—partitionable task requiring communication

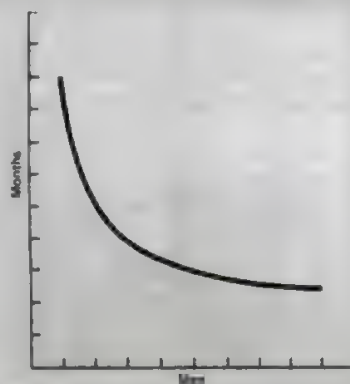
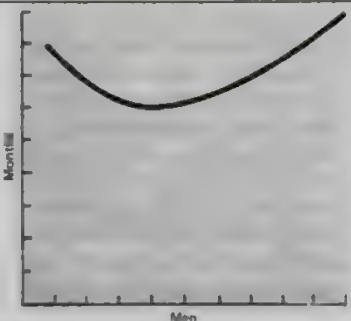


Figure 5: Time versus number of workers—task with complex interrelationships



estimates, software managers often lack the courteous stubbornness of Antoine's chef.

Fourth, schedule progress is poorly monitored. Techniques proven and routine in other engineering disciplines are considered radical innovations in software engineering.

Fifth, when schedule slippage is recognized, the natural (and traditional) response is to add manpower. Like dousing a fire with gasoline, this makes matters worse, much worse. More fire requires more gasoline, and thus begins a regenerative cycle which ends in disaster.

Schedule monitoring will be the subject of a separate essay. Let us consider other aspects of the problem in more detail.

### Optimism

All programmers are optimists. Perhaps this modern sorcery especially attracts those who believe in happy endings and fairy godmothers. Perhaps the hundreds of nitty frustrations drive away all but those who habitually focus on the end goal. Perhaps it is merely that computers are young, programmers are younger, and the young are always optimists. But however the selection process works, the result is indisputable: "This time it will surely run," or "I just found the last bug."

So the first false assumption that underlies the scheduling of systems programming is that all will go well, i.e., that each task will take only as long as it "ought" to take.

## ***THE incompleteness and inconsistencies of our ideas become clear only during implementation.***

The pervasiveness of optimism among programmers deserves more than a flip analysis. Dorothy Sayers, in her excellent book, *The Mind of the Maker*, divides creative activity into three stages: the idea, the implementation, and the interaction. A book, then, or a computer, or a program comes into existence first as an ideal con-

struct, built outside time and space, but complete in the mind of the author. It is realized in time and space, by pen, ink, and paper, or by wire, silicon, and ferrite. The creation is complete when someone reads the book, uses the computer, or runs the program, thereby interacting with the mind of the maker.

This description, which Miss Sayers uses to illuminate not only human creative activity but also the Christian doctrine of the Trinity, will help us in our present task. For the human makers of things, the incompleteness and inconsistencies of our ideas become clear only during implementation. Thus it is that writing, experimentation, "working out" are essential disciplines for the theoretician.

In many creative activities the medium of execution is intractable. Lumber splits; paints smear; electrical circuits ring. These physical limitations of the medium constrain the ideas that may be expressed, and they also create unexpected difficulties in the implementation.

Implementation, then, takes time and sweat both because of the physical media and because of the inadequacies of the underlying ideas. We tend to blame the physical media for most of our implementation difficulties; for the media are not "ours" in the way the ideas are, and our pride colors our judgment.

Computer programming, however, creates with an exceedingly tractable medium. The programmer builds from pure thought-stuff: concepts and very flexible representations thereof. Because the medium is tractable, we expect few difficulties in implementation; hence our pervasive optimism. Because our ideas are faulty, we have bugs; hence our optimism is unjustified.

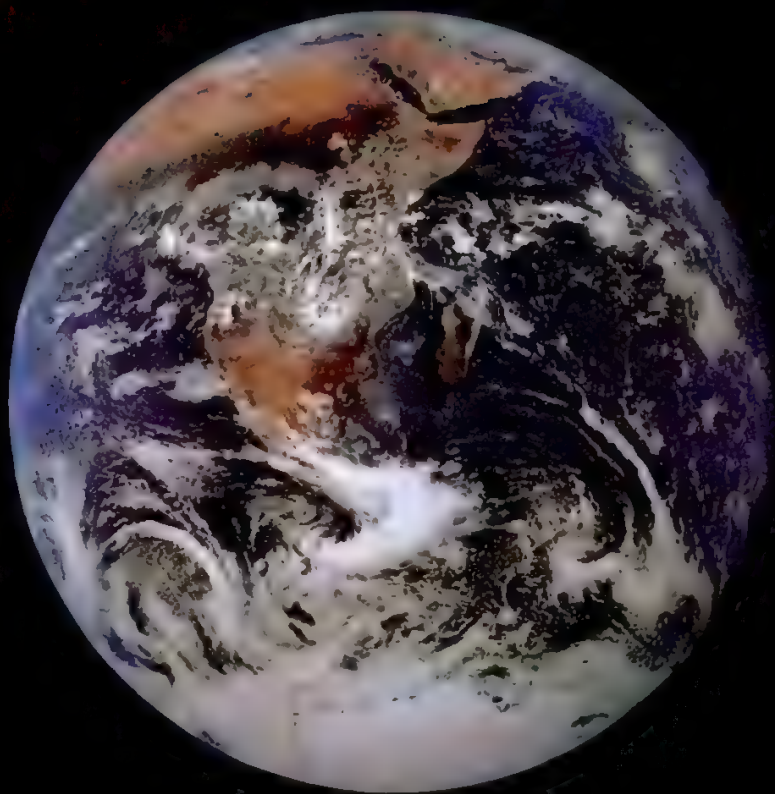
In a single task, the assumption that all will go well has a probabilistic effect on the schedule. It might indeed go as planned, for there is a probability distribution for the delay that will be encountered, and "no delay" has a finite probability. A large programming effort, however, consists of many tasks, some chained end-to-end. The probability that each will go well becomes vanishingly small.

### The Man-Month

The second fallacious thought mode is expressed in the very unit of effort used in estimating and scheduling: the man-



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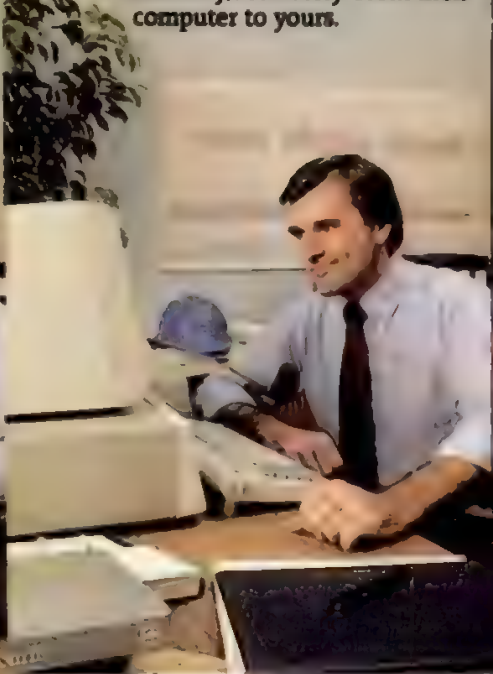
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month. Cost does indeed vary as the product of the number of men and the number of months. Progress does not. Hence the man-month as a unit for measuring the size of a job is a dangerous and deceptive myth. It implies that men and months are interchangeable.

Men and months are interchangeable commodities only when a task can be partitioned among many workers with no communication among them (Figure 2). This is true of reaping wheat or picking cotton; it is not even approximately true of systems programming.

When a task cannot be partitioned because of sequential constraints, the application of more effort has no effect on the schedule (Figure 3). The bearing of a child takes nine months, no matter how many women are assigned. Many software tasks have this characteristic because of the sequential nature of debugging.

In tasks that can be partitioned but which require communication among the subtasks, the effort of communication must be added to the amount of work to be done. Therefore the best that can be done is somewhat poorer than an even trade of men for months (Figure 4).

The added burden of communication is made up of two parts, training and intercommunication. Each worker must be trained in the technology, the goals of the effort, the overall strategy, and the plan of work. This training cannot be partitioned, so this part of the added effort varies linearly with the number of workers.<sup>2</sup>

Intercommunication is worse. If each part of the task must be separately coordinated with each other part, the effort increases as  $n(n-1)/2$ . Three workers require three times as much pairwise intercommunication as two; four require six times as much as two. If, moreover, there need to be conferences among three, four, etc., workers to resolve things jointly, matters get worse yet. The added effort of communicating may fully counteract the division of the original task and bring us to the situation of Figure 5.

Since software construction is inherently a systems effort—an exercise in complex interrelationships—communication effort is great, and it quickly dominates the decrease in individual task time brought about by partitioning. Adding more men then lengthens, not shortens, the schedule.

Oversimplifying outrageously, we state Brooks's Law:

*Adding manpower to a late software project makes it later.*

This then is the demythologizing of the man-month. The number of months of a project depends upon its sequential constraints. The maximum number of men depends upon the number of inde-

pendent subtasks. From these two quantities one can derive schedules using fewer men and more months. (The only risk is product obsolescence.) One cannot, however, get workable schedules using more men and fewer months. More software projects have gone awry for lack of calendar time than for all other causes combined.

## Passing the Word

He'll sit here and he'll say, "Do this! Do that!" And nothing will happen.

—HARRY S. TRUMAN, ON PRESIDENTIAL POWER<sup>3</sup>

Assuming that he has the disciplined, experienced architects and that there are many implementers, how shall the manager ensure that everyone hears, understands, and implements the architects' decisions? How can a group of 10 architects maintain the conceptual integrity of a system which 1000 men are building? A whole technology for doing this was worked out for the System/360 hardware design effort, and it is equally applicable to software projects.

### Written Specifications—the Manual

The manual, or written specification, is a necessary tool, though not a sufficient one. The manual is the external specification of the product. It describes and prescribes every detail of what the user sees. As such, it is the chief product of the architect.

Round and round goes its preparation cycle, as feedback from users and implementers shows where the design is awkward to use or build. For the sake of implementers it is important that the changes be quantized—that there be dated versions appearing on a schedule.

The manual must not only describe everything the user does see, including all interfaces; it must also refrain from describing what the user does not see. That is the implementer's business, and there his design freedom must be unconstrained. The architect must always be prepared to show an implementation for any feature he describes, but he must not attempt to dictate the implementation.

The style must be precise, full, and accurately detailed. A user will often refer to a single definition, so each one must repeat all the essentials and yet all must

agree. This tends to make manuals dull reading, but precision is more important than liveliness.

The unity of System/360's *Principles of Operation* springs from the fact that only two pens wrote it: Gerry Blaauw's and Andris Padegs'. The ideas are those of about ten men, but the casting of those decisions into prose specifications must be done by only one or two, if the consistency of prose and product is to be maintained. For the writing of a definition will necessitate a host of mini-decisions which are not of full-debate importance. An example in System/360 is the detail of how the Condition Code is set after each operation. Not trivial, however, is the principle that such mini-decisions be made consistently throughout.

I think the finest piece of manual writing I have ever seen is Blaauw's Appendix to System/360 *Principles of Operation*. This describes with care and precision the limits of System/360 compatibility. It defines compatibility, prescribes what is to be achieved, and enumerates those areas of external appearance where the architecture is intentionally silent and where results from one model may differ from those of another, where one copy of a given model may differ from another copy, or where a copy may differ even from itself after an engineering change. This is the level of precision to which manual writers aspire, and they must define what is not prescribed as carefully as what is.

### Formal Definitions

English, or any other human language, is not naturally a precision instrument for such definitions. Therefore the manual writer must strain himself and his lan-



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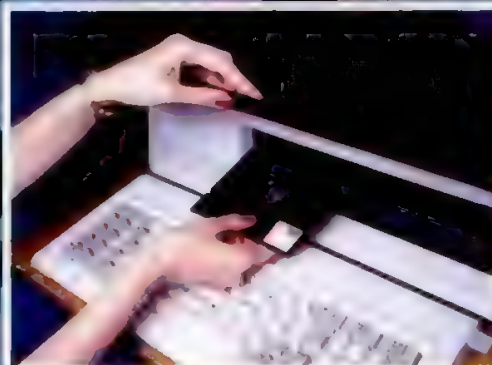
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guage to achieve the precision needed. An attractive alternative is to use a formal notation for such definitions. After all, precision is the stock in trade, the *raison d'être* of formal notations.

Let us examine the merits and weaknesses of formal definitions. As noted, formal definitions are precise. They tend to be complete; gaps show more conspicuously, so they are filled sooner. What they lack is comprehensibility. With English prose one can show structural principles, delineate structure in stages or levels, and give examples. One can readily mark exceptions and emphasize contrasts. Most important, one can explain why. The formal definitions put forward so far have inspired wonder at their elegance and confidence in their precision. But they

have demanded prose explanations to make their content easy to learn and teach. For these reasons, I think we will see future specifications to consist of both a formal definition and a prose definition.

An ancient adage warns, "Never go to sea with two chronometers; take one or three." The same thing clearly applies to prose and formal definitions. If one has both, one must be the standard, and the other must be a derivative description, clearly labeled as such. Either can be the primary standard. Algol 68 has a formal definition as standard and a prose definition as descriptive. PL/I has the prose as standard and the formal description as derivative. System/360 also has prose as standard with a derived formal description.

10,000 gallon/day capacity before being used for a 2,000,000 gallon/day community water system.

Programming system builders have also been exposed to this lesson, but it seems to have not yet been learned. Project after project designs a set of algo-

---

**T**HE BEST  
*planning is not so  
 omniscient as to get it  
 right the first time.*

---

rithms and then plunges into construction of customer-deliverable software on a schedule that demands delivery of the first thing built.

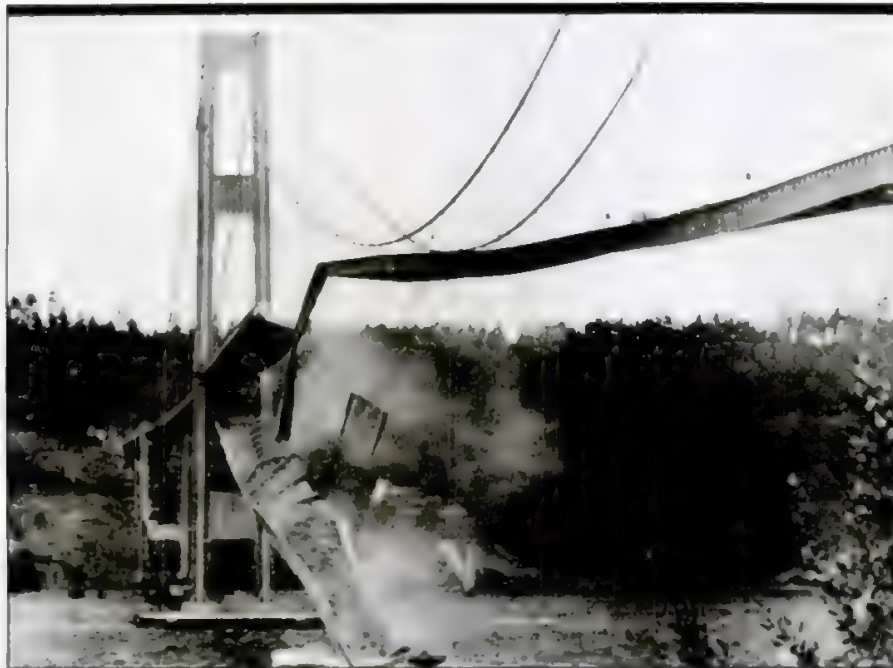
In most projects, the first system built is barely usable. It may be too slow, too big, awkward to use, or all three. There is no alternative but to start again, smarting but smarter, and build a redesigned version in which these problems are solved. The discard and redesign may be done in one lump, or it may be done piece-by-piece. But all large-system experience shows that it will be done.<sup>5</sup> Where a new system concept or new technology is used, one has to build a system to throw away, for even the best planning is not so omniscient as to get it right the first time.

The management question, therefore, is not *whether* to build a pilot system and throw it away. You will do that. The only question is whether to plan in advance to build a throwaway, or to promise to deliver the throwaway to customers. Seen this way, the answer is much clearer. Delivering that throwaway to customers buys time, but it does so only at the cost of agony for the user, distraction for the builders while they do the redesign, and a bad reputation for the product that the best redesign will find hard to live down.

Hence plan to throw one away; you will, anyhow.

### The Only Constancy Is Change Itself

Once one recognizes that a pilot system must be built and discarded, and that a



Collapse of the aerodynamically misdesigned Tacoma Narrows Bridge, 1940

## Plan to Throw One Away

*There is nothing in this world constant but inconstancy.*

—SWIFT

*It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something.*

—FRANKLIN D. ROOSEVELT<sup>6</sup>

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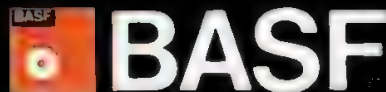
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redesign with changed ideas is inevitable, it becomes useful to face the whole phenomenon of change. The first step is to accept the fact of change as a way of life, rather than an untoward and annoying exception. Cosgrove has perceptively pointed out that the programmer delivers satisfaction of a user need rather than any tangible product. And both the actual need and the user's perception of that need will change as programs are built, tested, and used.<sup>6</sup>

Of course this is also true of the needs met by hardware products, whether new cars or new computers. But the very existence of a tangible object serves to contain and quantize user demand for changes. Both the tractability and the invisibility of the software product expose its builders to perpetual changes in requirements.

Far be it from me to suggest that all changes in customer objectives and requirements must, can, or should be incorporated in the design. Clearly a threshold has to be established, and it must get higher and higher as development proceeds, or no product ever appears.

Nevertheless, some changes in objectives are inevitable, and it is better to be prepared for them than to assume that they won't come. Not only are changes in objective inevitable, changes in development strategy and technique are also inevitable. The throw-one-away concept is itself just an acceptance of the fact that as one learns, he changes the design.<sup>7</sup>

---

**T**  
**HE**  
*throw-one-away  
concept is itself just an  
acceptance of the fact  
that as one learns, he  
changes the design.*

---

#### Plan the System for Change

The ways of designing a system for such change are well known and widely discussed in the literature—perhaps more

widely discussed than practiced. They include careful modularization, extensive subroutining, precise and complete definition of intermodule interfaces, and complete documentation of these. Less obviously one wants standard calling sequences and table-driven techniques used wherever possible.

Most important is the use of a high-level language and self-documenting techniques so as to reduce errors induced by changes. Using compile-time operations to incorporate standard declarations helps powerfully in making changes.

Quantization of change is an essential technique. Every product should have numbered versions, and each version must have its own schedule and a freeze date, after which changes go into the next version.

#### Two Steps Forward and One Step Back

A program doesn't stop changing when it is delivered for customer use. The changes after delivery are called program maintenance, but the process is fundamentally different from hardware maintenance.

Hardware maintenance for a computer system involves three activities—replacing deteriorated components, cleaning and lubricating, and putting in engineering changes that fix design defects. (Most, but not all, engineering changes fix defects in the realization or implementation, rather than the architecture, and so are invisible to the the user.)

Program maintenance involves no cleaning, lubrication, or repair of deterioration. It consists chiefly of changes that repair design defects. Much more often than with hardware, these changes in-

clude added functions. Usually they are visible to the user.

The total cost of maintaining a widely used program is typically 40 percent or more of the cost of developing it. Surprisingly, this cost is strongly affected by the number of users. More users find more bugs.

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**O****LD BUGS**  
*found and solved in  
previous releases tend to  
reappear in a new  
release.*

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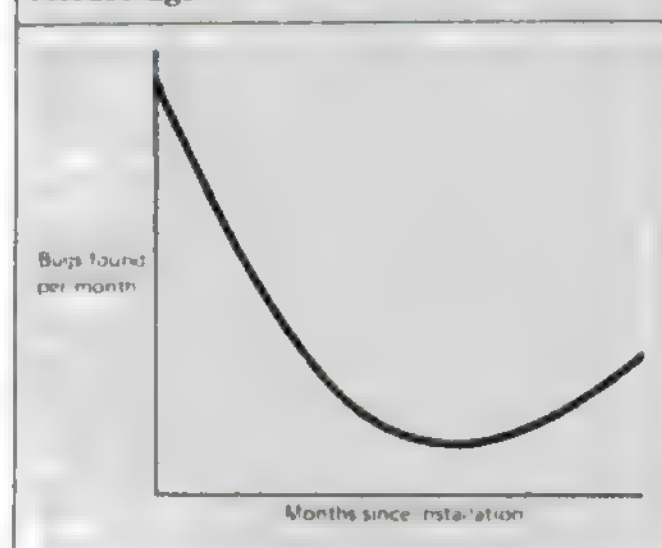
Betty Campbell, of MIT's Laboratory of Nuclear Science, points out an interesting cycle in the life of a particular release of a program. It is shown in Figure 6. Initially, old bugs found and solved in previous releases tend to reappear in a new release. New functions of the new release turn out to have defects. These things get shaken out, and all goes well for several months. Then the bug rate begins to climb again. Miss Campbell believes this is due to the arrival of users at a new plateau of sophistication, where they begin to exercise fully the new capabilities of the release. This intense workout then smokes out the more subtle bugs in the new features.<sup>8</sup>

The fundamental problem with program maintenance is that fixing a defect has a substantial (20-50 percent) chance of introducing another. So the whole process is two steps forward and one step back.

Why aren't defects fixed more cleanly? First, even a subtle defect shows itself as a local failure of some kind. In fact it often has system-wide ramifications, usually nonobvious. Any attempt to fix it with minimum effort will repair the local and the obvious, but unless the structure is pure or the documentation very fine, the far-reaching effects of the repair will be overlooked. Second, the repairer is usually not the man who wrote the code, and often he is a junior programmer or trainee.

As a consequence of the introduction of new bugs, program maintenance requires far more system testing per state-

Figure 6: Bug occurrence as a function of release age





ment written than any other programming. Theoretically, after each fix one must run the entire bank of test cases previously run against the system, to ensure that it has not been damaged in an obscure way. In practice such regression testing must indeed approximate this theoretical ideal, and it is very costly.

Clearly, methods of designing programs so as to eliminate or at least illuminate side effects can have an immense payoff in maintenance costs. So can methods of implementing designs with fewer people, fewer interfaces, and hence fewer bugs.

### One Step Forward and One Step Back

Lehman and Belady have studied the history of successive releases in a large operating system.<sup>8</sup> They find that the total number of modules increases linearly with release number, but that the number of modules affected increases exponentially with release number. All repairs tend to destroy the structure, to increase the entropy and disorder of the system. Less and less effort is spent on fixing original design flaws; more and more is spent on fixing flaws introduced by earlier fixes. As time passes, the system becomes less and less well-ordered. Sooner or later the fixing ceases to gain any ground. Each forward step is matched by a backward one. Although in principle usable forever, the system has worn out as a base for progress. Furthermore, machines change, configurations change, and user requirements change, so the system is not in fact usable forever. A brand-new, from-the-ground-up redesign is necessary.

And so from a statistical mechanical model, Belady and Lehman arrive for programming-systems at a more general conclusion supported by the experience of all the earth. "Things are always at their best in the beginning," said Pascal. C.S. Lewis has stated it more perceptively:

*That is the key to history. Terrific energy is expended—civilizations are built up—excellent institutions devised; but each time something goes wrong. Some fatal flaw always brings the selfish and cruel people to the top, and then it all slides back into misery and ruin. In fact, the machine conks. It seems to start up all right and runs a few yards, and then it breaks down.<sup>10</sup> Systems program building is an entro-*

py-decreasing process, hence inherently metastable. Program maintenance is an entropy-increasing process, and even its

most skillful execution only delays the subsidence of the system into unfixable obsolescence.

## The Whole and the Parts

*I can call spirits from the vasty deep. Why so can I, or so can any man; but will they come when you do call for them?*

—SHAKESPEARE, KING HENRY IV, PART I

**T**he modern magic, like the old, has its boastful practitioners: "I can write programs that control air traffic, intercept ballistic missiles, reconcile bank accounts, control production lines." To which the answer comes, "So can I, and so can any man, but do they work when you do write them?"

How does one build a program to work? How does one test a program? And how does one integrate a tested set of component programs into a tested and dependable system? We have touched upon the techniques here and there; let us now consider them somewhat more systematically.

### Designing the Bugs Out

**Bug-proofing the definition.** The most pernicious and subtle bugs are system bugs arising from mismatched assumptions made by the authors of various components. In short, conceptual integrity of the product not only makes it easier to use, it also makes it easier to build and less subject to bugs.

So does the detailed, painstaking architectural effort implied by that approach. V.A. Vyssotsky, of Bell Telephone Laboratories' Safeguard Project, says, "The crucial task is to get the product defined. Many, many failures concern exactly those aspects that were never quite specified."<sup>11</sup> Careful function definition, careful specification, and the disciplined exorcism of frills of function and flights of technique all reduce the number of system bugs that have to be found.

**Testing the specification.** Long before any code exists, the specification must be handed to an outside testing group to be scrutinized for completeness and clarity. As Vyssotsky says, the developers themselves cannot do this: "They won't tell you they don't understand it; they will happily invent their way through the gaps and obscurities."

**Top-down design.** In a very clear 1971

paper, Niklaus Wirth formalized a design procedure which had been used for years by the best programmers.<sup>12</sup> Furthermore, his notions, although stated for program design apply completely to the design of complex systems of programs. The division of system building into architecture, implementation, and realization is an embodiment of these notions; furthermore, each of the architecture, implementation, and realization can be best done by top-down methods.

Briefly, Wirth's procedure is to identify design as a sequence of refinement steps. One sketches a rough task definition and a rough solution method that achieves the principal result. Then one examines the definition more closely to see how the result differs from what is wanted, and one takes the large steps of the solution and breaks them down into smaller steps. Each refinement in the definition of the task becomes a refinement in the algorithm for solution, and each may be accompanied by a refinement in the data representation.

From this process one identifies modules of solution or of data whose further refinement can proceed independently of other work. The degree of this modularity determines the adaptability and changeability of the program. Wirth advocates using as high-level a notation as is possible at each step, exposing the concepts and concealing the details until further refinement becomes necessary.

A good top-down design avoids bugs in several ways. First, the clarity of structure and representation makes the precise statement of requirements and functions of the modules easier. Second, the partitioning and independence of modules avoids system bugs. Third, the suppression of detail makes flaws in the structure more apparent. Fourth, the design can be tested at each of its refinement steps, so testing can start earlier and focus on the proper level of detail at each step.



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The process of step-wise refinement does not mean that one never has to go back, scrap the top level, and start the whole thing again as he encounters some

---

**I** AM  
*persuaded that top-  
down design is the most  
important new  
programming  
formalization of the  
decade.*

---

unexpectedly knotty detail. Indeed, that happens often. But it is much easier to see exactly when and why one should throw away a gross design and start over. Many poor systems come from an attempt to salvage a bad basic design and patch it with all kinds of cosmetic relief. Top-down design reduces the temptation.

I am persuaded that top-down design is the most important new programming formalization of the decade.

**Structured programming.** Another important set of new ideas for designing the bugs out of programs derives largely from Dijkstra,<sup>13</sup> and is built on a theoretical structure by Böhm and Jacopini.<sup>14</sup>

Basically the approach is to design programs whose control structures consist only of loops defined by a statement such as DO WHILE, and conditional portions delineated into groups of statements marked with brackets and conditioned by an IF . . . THEN . . . ELSE. Böhm and Jacopini show these structures to be theoretically sufficient; Dijkstra argues that the alternative, unrestrained branching via GO TO, produces structures that lend themselves to logical errors.

The basic notion is surely sound. Many criticisms have been made, and additional control structures, such as an n-way branch (the so-called CASE statement) for distinguishing among many contingencies, and a disaster bail-out (GO TO ABNORMAL END) are very convenient. Further, some have become very doctrinaire about avoiding all GO TO's, and that seems excessive.

The important point, and the one vital to constructing bug-free programs, is that one wants to think about the control structures of a system as control structures, not as individual branch statements. This way of thinking is a major step forward.

### **Component Debugging**

The procedures for debugging programs have been through a great cycle in the past twenty years, and in some ways they are back where they started. The cycle has gone through four steps, and it is fun to trace them and see the motivation for each.

**On-machine debugging.** Early machines had relatively poor input-output equipment, and long input-output delays. Typically, the machine read and wrote paper tape or magnetic tape and off-line facilities were used for tape preparation and printing. This made tape input-output intolerably awkward for debugging, so the console was used instead. Thus debugging was designed to allow as many trials as possible per machine session.

The programmer carefully designed his debugging procedure—planning where to stop, what memory locations to examine, what to find there, and what to do if he didn't. This meticulous programming of himself as a debugging machine might well take half as long as writing the computer program to be debugged.

The cardinal sin was to push START boldly without having segmented the program into test sections with planned stops.

**Memory dumps.** On-machine debugging was very effective. In a two-hour session, one could get perhaps a dozen shots. But computers were very scarce, and very costly, and the thought of all that machine time going to waste was horrifying.

So when high-speed printers were attached on-line, the technique changed. One ran a program until a check failed, and then dumped the whole memory. Then began the laborious desk work, accounting for each memory location's contents. The desk time was not much different than that for on-machine debugging; but it occurred after the test run, in deciphering, rather than before, in planning. Debugging for any particular user took much longer, because test shots depended upon batch turnaround time. The whole procedure, however, was designed to minimize computer time use,

and to serve as many programmers as possible.

**Snapshots.** The machines on which memory dumping was developed had 2000-4000 words, or 8K to 16K bytes of memory. But memory sizes grew by leaps and bounds, and total memory dumping became impractical. So people developed techniques for selective dumping, selective tracing, and for inserting snapshots into programs. The OS/360 TESTRAN is an end-of-the-line in this direction, allowing one to insert snapshots into a program without reassembly or recompilation.

**Interactive debugging.** In 1959 Codd and his coworkers<sup>15</sup> and Strachey<sup>16</sup> each reported work aimed at time-shared debugging, a way of achieving both the instant turnaround of on-machine debugging and the efficient machine use of batch debugging. The computer would have multiple programs in memory, ready for execution. A terminal controlled only by program, would be associated with each program being debugged. Debugging would be under control of a supervisory program. When the programmer at a terminal stopped his program to examine progress or to make changes, the supervisor would run another program, thus keeping the machines busy.

---

**T**HE  
*cardinal sin was to push  
START boldly without  
having segmented the  
program into test  
sections with planned  
stops.*

---

Codd's multiprogramming system was developed, but the emphasis was on throughput enhancement by efficient input-output utilization and interactive debugging was not implemented. Strachey's ideas were improved and implemented in 1963 in an experimental system for the 7090 by Corbató and colleagues at MIT.<sup>17</sup> This development led to the MULTICS, TSS, and other timesharing systems of today.



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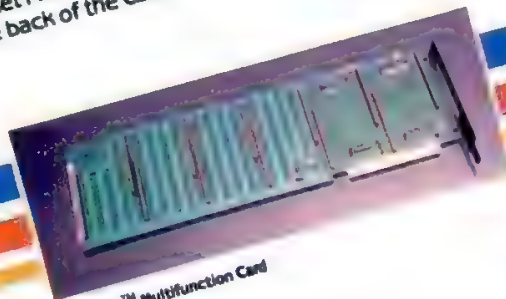
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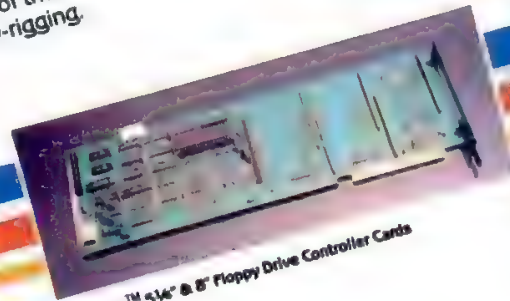
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```
cursor(left = noaction) +
cursor(up   = noaction) +
           = noaction)
```

(DOS COMMANDS)

```
t = fly
= fly
= fly
= fly
```

(DOS COMMANDS)

List files on a

List files on b

Display window dir

Display

Display

Display file

Display file

Display file

VisuALL

```
Copy block = button(middle = a-b) button(right
Overlay block = button(middle = a-b) button(right
Delete block = a-a button(middle = a-b) button(r
Print block = button(middle = a-b) button(right
Move line = button(middle = a-l) button(right
```

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The chief user-perceived differences between on-machine debugging at first practiced and the interactive debugging of today are the facilities made possible by the presence of the supervisory program and its associated language interpreters. One can program and debug in a high-level language. Efficient editing facilities make changes and snapshots easy.

---

**C**OMMON  
*sense, if not common  
practice, dictates that  
one should begin system  
debugging only after the  
pieces seem to work.*

---

Return to the instant-turnaround capability of on-machine debugging has not yet brought a return to the preplanning of debugging sessions. In a sense such preplanning is not so necessary as before, since machine time doesn't waste away while one sits and thinks.

Nevertheless, Gold's interesting experimental results show that three times as much progress in interactive debugging is made on the first interaction of each session as on subsequent interactions.<sup>18</sup> This strongly suggests that we are not realizing the potential of interaction due to lack of session planning. The time has come to dust off the old on-machine techniques.

I find that proper use of a good terminal system requires two hours at the desk for each two-hour session on the terminal. Half of this time is spent in sweeping up after the last session: updating my debugging log, filing updated program listings in my system notebook, explaining strange phenomena. The other half is spent in preparation: planning changes and improvements and designing detailed test for next time. Without such planning, it is hard to stay productive for as much as two hours. Without the post-session sweep-up, it is hard to keep the succession of terminal sessions systematic and forward-moving.

**Test cases.** As for the design of actual debugging procedures and test cases, Gruenberger has an especially good treat-

ment,<sup>19</sup> and there are shorter treatments in other standard tests.<sup>20,21</sup>

### System Debugging

The unexpectedly hard part of building a programming system is system test. I have already discussed some of the reasons for both the difficulty and its unexpectedness. From all of that, one should be convinced of two things: System debugging will take longer than one expects, and its difficulty justifies a thoroughly systematic and planned approach. Let us now see what such an approach involves.<sup>22</sup>

**Use debugged components.** Common sense, if not common practice, dictates that one should begin system debugging only after the pieces seem to work.

Common practice departs from this in two ways. First is the bolt-it-together-and-try approach. This seems to be based on the notion that there will be system (i.e., interface) bugs in addition to the component bugs. The sooner one puts the pieces together, the sooner the system bugs will emerge. Somewhat less sophisticated is the notion that by using the pieces to test each other, one avoids a lot of test scaffolding. Both of these are obviously true, but experience shows that they are not the whole truth—the use of clean, debugged components saves much more time in system testing than that spent on scaffolding and thorough component test.

A little more subtle is the “documented bug” approach. This says that a component is ready to enter system test when all the flaws are found, well before the time when all are fixed. Then in system testing, so the theory goes, one knows the expected effects of these bugs and can ignore those effects, concentrating on the new phenomena.

All this is just wishful thinking, invented to rationalize away the pain of slipped schedules. One does not know all the expected effects of known bugs. If things were straightforward, system testing wouldn't be hard. Furthermore, the fixing of the documented component bugs will surely inject unknown bugs, and then system test is confused.

**Build plenty of scaffolding.** By scaffolding I mean all programs and data built for debugging purposes but never intended to be in the final product. It is not unreasonable for there to be half as much code in scaffolding as there is in product.

One form of scaffolding is the dummy

component, which consists only of interfaces and perhaps some faked data or some small test cases. For example, a system may include a sort program which isn't finished yet. Its neighbors can be tested by using a dummy program that merely reads and tests the format of input data, and spews out a set of well-formatted meaningless but ordered data.

Another form is the *miniature file*. A very common form of system bug is misunderstanding of formats for tape and disk files. So it is worthwhile to build some little files that have only a few typical records, but all the descriptions, pointers, etc.

The limiting case of miniature file is the *dummy file*, which really isn't there at all. OS/360's Job Control Language provides such facility, and it is extremely useful for component debugging.

Yet another form of scaffolding are auxiliary programs. Generators for test data, special analysis printouts, and cross-reference table analyzers, are all examples of the special-purpose jigs and fixtures one may want to build.<sup>23</sup>

**Control changes.** Tight control during test is one of the impressive techniques of hardware debugging, and it applies as well to software systems.

First, somebody must be in charge. He and he alone must authorize component changes or substitution of one version for another.

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**T**HE  
*fixing of the documented  
component bugs will  
surely inject unknown  
bugs.*

---

Then, as discussed above, there must be controlled copies of the system: one locked-up copy of the latest versions, used for component testing; one copy under test, with fixes being installed; and playpen copies where each man can work away on his component, doing both fixes and extensions.

In System/360 engineering models, one saw occasional strands of purple wire

among the routine yellow wires. When a bug was found, two things were done. A quick fix was devised and installed on the system, so testing could proceed. This change was put on in purple wire, so it stuck out like a sore thumb. It was entered in the log. Meanwhile, an official change document was prepared and started into the design automation mill. Eventually this resulted in updated drawings and wire lists, and a new back panel in which the change was implemented in printed

circuitry or yellow wire. Now the physical model and the paper were together again, and the purple wire was gone.

Programming needs a purple-wire technique, and it badly needs tight control and deep respect for the paper that ultimately is the product. The vital ingredients of such technique are the logging of all changes in a journal and the distinction, carried conspicuously in source code, between quick patches and thought-through, tested, documented fixes.

Add one component at a time. This precept, too, is obvious, but optimism and laziness tempt us to violate it. To do it requires dummies and other scaffolding, and that takes work. After all, perhaps all that work won't be needed? Perhaps there are no bugs?

No! Resist the temptation! That is what systematic system testing is all about. One must assume that there will be lots of bugs, and plan an orderly procedure for snaking them out. /PC

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IBM PC ENHANCEMENTS, NO ONE OFFERS:

- More complete IBM PC expandability
- More solutions to today's business and technical computing problems
- More assurance of future compatibility with the next generation of technology
- More product reliability

TECMAR IS THE SAFE DECISION FOR TOMORROW'S PRODUCTS

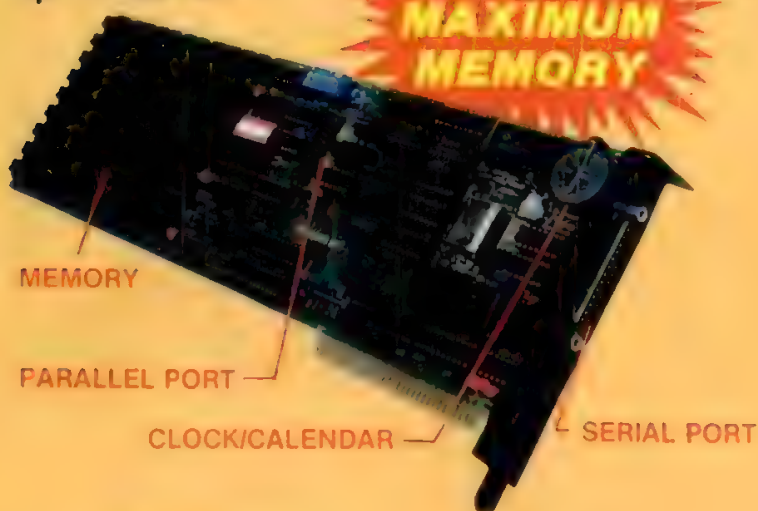
**TECMAR** THE ONLY NAME YOU'LL NEED TO KNOW

CIRCLE 44 ON READER SERVICE CARD

# FIRST FROM TECMAR

**\$795<sup>00</sup>**

**NEW!  
MAXIMUM  
MEMORY**



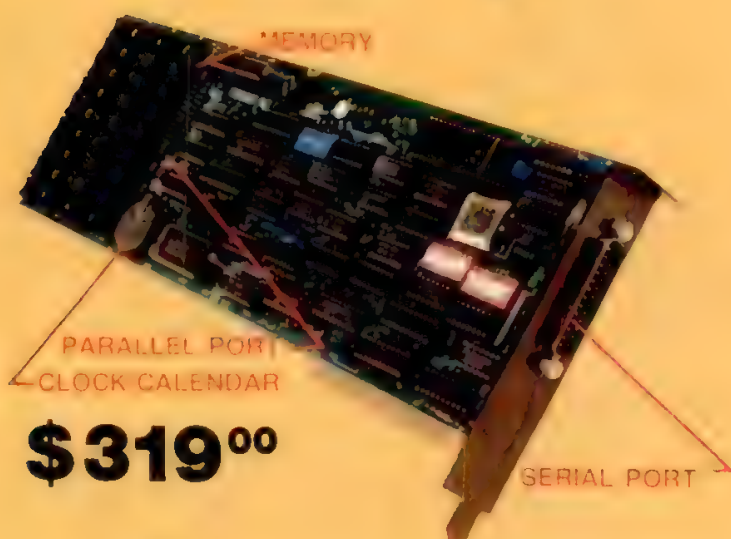
## CAPTAIN™

Provides the entire maximum 384K memory expansion for the PC XT or 384K extra RAM for the PC

### TECMAR'S TOP OF THE LINE MULTI-FUNCTION BOARD

Performs eight (8) key functions in one (1) expansion slot with upgradeable (expandable) memory.

- 0 to 384K MEMORY - fully socketed for easy field upgrade
- CLOCK/CALENDAR - with easily replaceable battery for back-up
- SERIAL PORT for communications — PC compatible (COM1, COM2)
- PARALLEL PORT for printer - PC compatible (LPT1, LPT2)
- RAMSPOOLER - easy to use - allows printing to become background task - choice of 8 memory sizes
- SPEED DISK - simulates ultra high speed disk
- AUTO-TIME - provides automatic insertion of date and time at power on
- Accepts exclusive PAL Option to restrict certain information on a "need to know" basis or to protect software
- Includes all connectors and cables
- Compatible with COMPAQ personal computer.



**\$319<sup>00</sup>**

## 1st MATE™

**\$319/Unpopulated Memory**  
**\$389/64K \$469/128K**  
**\$539/192K \$589/256K**

Performs eight (8) key functions (same as the Captain).

Versatile - each 64K fully addressable.

These features are the same as described for the Captain.

- |                  |              |
|------------------|--------------|
| • MEMORY         | • RAMSPOOLER |
| • CLOCK/CALENDAR | • SPEED DISK |
| • SERIAL PORT    | • AUTO-TIME  |
| • PARALLEL PORT  | • PAL        |



**\$295<sup>00</sup>**

## 2nd MATE™

A wide range of I/O options - 4 ports with a clock/calendar when memory is not necessary.

- Two (2) SERIAL PORTS for communications, quality printers, modems — PC compatible (COM1, COM2 or other)
- Two (2) PARALLEL PORTS for printers — PC compatible (LPT1, LPT2 or other)
- CLOCK/CALENDAR with easily replaceable battery for back-up
- Accepts exclusive PAL Option to restrict information on a 'need to know' basis or to protect software
- Two (2) cables - one (1) serial, one (1) parallel - included
- Compatible with TI Professional (requires special software) and COMPAQ personal computers



# PC MATES™ - A COMPLETE SERIES OF MULTI-FUNCTION MEMORY/COMMUNICATIONS BOARDS THAT GIVE YOU TOTAL VERSATILITY TO CONFIGURE YOUR SYSTEM.

## 3rd MATE™ ON-BOARD MODEM AND I/O OPTIONS

Pulse-dialing supported with no external cables or wiring. All you need is a phone jack.

- **MODEM** - 300 Baud, Bell 103, auto-dial, pulse-dialing supported, on board
- **SERIAL PORT** - for additional communications - PC compatible (COM1, COM2 or other)
- Two (2) **PARALLEL PORTS** for printers - PC compatible (LPT1, LPT2 or other)
- **CLOCK/CALENDAR** with easily replaceable battery for back-up
- Designed to accept exclusive **PAL** Option to restrict certain information on a "need to know" basis or to protect software
- Two (2) cables - one (1) serial, one (1) parallel - included
- Compatible with TI Professional and COMPAQ personal computers

**NEW!**



**\$445<sup>00</sup>**

## Scribe Tender™

Combines three (3) IBM options on one (1) multi-function board

- Two (2) asynchronous **SERIAL PORTS** identical to IBM ports, (COM1, COM2 or other) fully programmable
- Complete status reporting
- One (1) **PARALLEL PORT** emulates IBM printer adapter board, (LPT1) including software capability
- Compatible with TI Professional and COMPAQ personal computers



**\$195<sup>00</sup>**

## Triporter™

Designed to provide easy access to the connectors on multi-function boards, such as the Tecmar Scribe Tender, 1st MATE, 2nd MATE, 3rd MATE. Provides for mounting of up to four (4) male or female DB25 connectors on back of IBM PC or Tecmar Expansion Chassis slot. (Cables \$25 extra)

- Easy to install
- Accommodates 26 conductor cables
- Mounts in expansion slot opening
- Housed in steel case



**\$95<sup>00</sup>**

### THE TECMAR PRODUCT LINE ADVANTAGES

- All Tecmar products carry a full one (1) year warranty
- Guaranteed 72 hour repair service (24 hour average)
- Total compatibility with IBM PC and all Tecmar products
- Proven reliability
- Strong manufacturer's support with immediate access to Customer Service
- Largest selection of IBM PC compatible products in the world

Most products compatible with Compaq, Columbia and TI PCs

# TECMAR

6225 Cochran Road  
Cleveland, Ohio 44139  
Phone: 216-349-0600 Telex: 466692

CIRCLE 49 ON READER SERVICE CARD



# FIRST FROM TECMAR

## NEW REMOVABLE CARTRIDGE WINCHESTER

Write for new Tecmar Information Kit.

### TECMAR

Personal Computer Products Division  
6225 Cochran Road  
Cleveland, Ohio 44139  
Phone: 216-349-0600/Telex: 466692

CIRCLE 497 ON READER SERVICE CARD

**TECMAR**  
**\$1795.00**

complete with  
controller & cartridge

This is the breakthrough in storage that IBM PC people have been waiting for, as Tecmar engineering keeps you moving ahead.

- the new SyQuest 5 Megabyte removable cartridge Winchester disk drive
- complete, easily installed in IBM PC or available in IBM-compatible Tecmar expansion chassis
- new Tecmar superspeed controller
- Tecmar disk sharing for up to 4 IBM PCs
- your best solution for mass storage, and the most sensible back-up system available

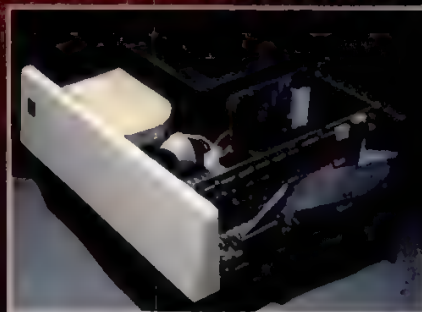
We believe this is the future in storage because we have proved its reliability and its advantages. The new removable cartridge gives you unlimited memory at a lower price tag than the basic Winchester at comparable speed.

**\$1795** complete with  
controller & cartridge  
AVAILABLE NOW AT YOUR TECMAR DEALER



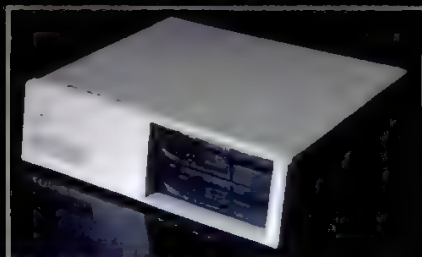
#### TECMAR COMPATIBILITY, VERSATILITY, RELIABILITY, AFFORDABILITY, RESPONDABILITY

The first and only complete line of fully compatible expansion options for IBM PCs, including every type of disk drive



#### NEW SHARED WINCHESTER PC-MATE™

Our new GT subsystem upgrades our original with 3 times faster speed, sharing for up to 4 IBM PCs . . . Controller Board available for upgrade on trade-in.



#### PC-MATE™ FLOPPY

Controller Board will handle 5 1/4" and 8" disks. Winchester can be installed in our floppy subsystem cabinet.



**TECMAR**  
**\$1595.00**

**PC-MATE BAK-PAK  
WINCHESTER BACK-UP 6.25  
MEGABYTE DISK PACK  
\$1595.00**

The "Bak-Pak" System comes in an IBM-Compatible/PC-MATE Mini-cabinet complete with software, power supply, controller and cables. Features removeable media in packs with 6.25 megabytes of formatted storage per pack. Additional packs available at \$95.00.

The controller substitutes for the IBM floppy disk controller, so no additional slots are necessary. Also can be used as primary high capacity storage system.

**TECMAR**  
**\$3995.00**

**HIGH CAPACITY STORAGE  
26 MEGABYTE WINCHESTER  
\$3995.00**

Comes in IBM Compatible/PC-MATE Mini-cabinet complete with software, power supply, controller and cables.

- Compatible with all Tecmar disk expansion systems
- Allows disk sharing for up to four (4) IBM PCs

26 Megabyte Winchester is also available in IBM-Compatible PC-MATE Expansion Chassis which offers an additional five (5) expansion slots and independent power supply for \$4295.00.

**Other Winchesters From Tecmar:**

- 10 Megabyte in Mini-cabinet - \$2495.00
- 15 Megabyte in Mini-cabinet - \$2895.00
- 10 Megabyte in PC-MATE Expansion Chassis - \$2795.00
- 15 Megabyte in PC-MATE Expansion Chassis - \$3195.00

Other configurations of fixed Winchester, removeable cartridge Winchester and 8" floppy disks are also available from Tecmar. Contact your local dealer or check Tecmar's full-line catalog for details.

**BACK-UP  
SYSTEMS  
SOLUTIONS**

**HIGH  
CAPACITY  
STORAGE  
SOLUTIONS**

Call or write for the latest catalog of PC-MATE peripherals from TECMAR. Updated continuously as new products come on-line.



**TECMAR  
THE ONLY NAME  
YOU NEED TO KNOW**

**WATCH THIS SPACE**

New! Tecmar Tape Back-Up  
Coming Soon



# TECMAR'S AFFORDABLE INDUSTRIAL/SCIENTIFIC LINE FOR THE IBM PC

## CONFIDENCE IS NO EXTRA CHARGE.

### COMPATIBLE

All TECMAR products are designed to be fully compatible with each other and the IBM PC for smooth, trouble-free performance in your system.

### SUPPORTABLE

Our philosophy of total support adds uncommon value to your TECMAR products. All TECMAR boards feature a one-year warranty, with guaranteed 72-hour maximum repair turnaround on all standard products. Replacement loaner units are available. Thorough and straightforward documentation comes with each unit. Our customer service staff is available to answer questions or solve your problems.

### EXPANDABLE

Our products allow easy expandability, so your system capabilities can grow with your needs.

There's more! TECMAR's broad line of compatible IBM PC Industrial/Scientific products includes:

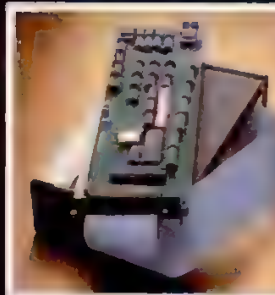
- High Resolution Graphics
- 5¼" and 8" Floppy Disc Controller
- Video Digitizer
- Video Cassette Recorder Controller
- Speech Synthesizer
- Voice Recognition
- D/A Converter
- Stepper Motor Controller
- EPROM or EEPROM Programmer/Reader
- Static RAM/ROM
- CMOS Memory



**IEEE488 INTERFACE  
plus SOFTWARE**

**\$395  
\$95**

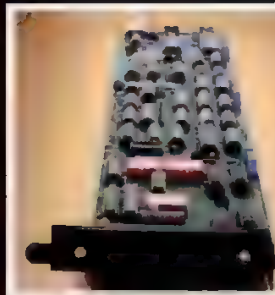
Board implements IEEE488 industry standard to enable PC to operate as system controller or as an addressed talker/listener. Has DMA and interrupt capabilities. Available library of machine-language subroutines called from BASIC or FORTRAN for data transactions with SDA. Order #20030 INTERFACE #30030.



**LAB MASTER™**

**\$995**

Sophisticated system that includes 16 channels of 12-bit A/D with a 30kHz conversion rate, two channels of 12-bit D/A, five timer/counters, and three 8-bit parallel ports. Options include programmable gain up to 1000, 14- and 16-bit accuracy, 40 and 100 kHz conversion, up to 256 channels. Order #20009.



**LAB TENDER™**

**\$495**

An economical and versatile system designed for data acquisition and control applications. Offers 32 channels of 8-bit A/D conversion, 16 channels of 8-bit D/A conversion, five timers, and three 8-bit parallel ports. Order #20028.



**BASE BOARD™**

**\$345**

Digital Input, Digital Output board with four sections of 24 DI/DO lines. Each section can be used as a stand-alone DI/DO interface or with a daughter board for prototyping or specific functions such as opto-isolated input or opto-isolated output. Order #20025.

We are proud to offer the largest line of options available anywhere for the IBM Personal Computer. All Tecmar products are designed with advanced technology as it becomes available. We add new products monthly like the PC-MATE removable Cartridge Winchester drive. TECMAR offers complete reliability and backs it up with support.

# TECMAR

PERSONAL COMPUTER PRODUCTS DIVISION  
6225 Cochran Road  
Cleveland, Ohio 44139  
Phone: 216-349-0600/Telex: 460002

Call or write for the latest catalog of PC-MATE peripherals from TECMAR. Updated continuously as new products come on-line.



CIRCLE 499 ON READER SERVICE CARD



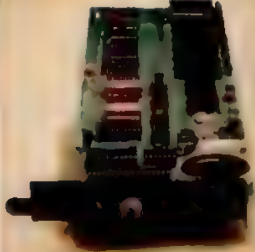
# PC MATE™

## SOLUTION-ORIENTED DESIGN WITH THE USER IN MIND A FULL LINE OF PROBLEM SOLVERS




**DIGITAL TO ANALOG AND  
DIGITAL INPUT/OUTPUT** \$395

Converts digital data to analog and vice versa. Features three (3) 8-bit parallel ports. Can con-



**SPEECH MASTER** \$395

synthesizer for unlimited vocabulary, and the NATIONAL



**VCR VCR VCR** \$345

software



**DEVICE MASTER** \$245  
plus SOFTWARE \$35

Can be used for energy management, security, or just for convenience. This



**CASSETTE RECORDER** \$485


controller



**CIRCUIT MASTER** \$485



**EEPROM PROGRAMMER/  
READER** \$495  
**EEPROM EXPANSION** \$595  
**EEPROM SOFTWARE** \$85



**MASTER** \$125

# TECMAR - THE ONLY NAME YOU NEED TO KNOW

CIRCLE 500 ON READER SERVICE CARD



# ELAN™

# Extended Local

## NETWORKING

- Ethernet
- Electronic mail
- Device sharing
- No dedicated server required
- Floppys not required in single node
- Remote job execution
- File lock out
- Password protection

## TELEPHONE SUPPORT

- available through modem board)
- Autodial - with extended telephone numbers
- Call Forwarding
- Length Of Call Indicator
- Directory Support with unlimited number storage
- Message Support either leave or obtain messages. Receive messages remotely
- The modem board, with a handset, substitutes for a telephone

## MODEM

- Gateway to other networks
- Electronic mail
- Device sharing
- Remote job execution
- File lock out
- Password protection
- 300 to 1200 baud modems available
- Data in network can be obtained by decoding touch-tone sequence or through voice recognition prompt
- Respond to remote terminal
- Access dictating systems on network. Control them by touch-tone decoding
- Programs or calculator can be used remotely. The touch-tone keypad can be used to provide numeric input to programs or the calculator from a remote site (programs are loaded by decoding touch-tone sequences).

## VOICE

- Voice mail
- Voice annotated text
- Voice messages

## VOICE RECOGNITION

- Transparent keyboard. Speak instead of type

## SECRETARY \$1695<sup>1</sup>

- Ethernet Link
- Ethernet Companion
- ELAN Software

## EXECUTIVE \$2995<sup>1</sup>

- Ethernet Link
- Ethernet Companion
- Modem (300 Baud)<sup>2</sup>
- Voice Recognition
- Microphone
- ELAN Software

## ELAN: THE MOST POWERFUL

ELAN is designed to meet your total communication needs, including computer to computer (networking), person-to-computer and person-to-person communication requirements for data and voice.

The network employs the industry-standard high speed Ethernet protocol, which permits a number of IBM PC's to be linked together by ordinary thin coaxial cable. In addition to his own computer's power, a user has the availability of other devices which are also attached to the cable - such as various printers, large disks, etc.

All versions of ELAN include an Ethernet interface and equipment to convert voice into data and back again. This enables one to give and receive spoken messages from any location. The SECRETARY is the basic system with these features.



<sup>1</sup>With 1st MATE, 2nd MATE, or 3rd MATE in Station

<sup>2</sup>Option: 1200 Baud Modem

\*ELAN (formerly ComNet)

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# Area Network from **TECMAR**

THE POWER BEHIND THE PC

## DICTATING SYSTEM

- Control the Pearlcarder X-02 or XR dictating system from keyboard, footpedal, or remote telephone keypad. Dictate to the net work from anywhere in the U.S. or Canada.

## FOOT PEDAL SUPPORT

- Controls dictating system
- Controls response to voice recognition

## SOFTWARE

- Time Management - alerts you to appointments at any station you are logged onto
- Message Management - either electronic mail or voice
- Clock/Calendar - either visual or audible
- Calculator - either visual or audible
- Voice Management - oversees voice mail, voice message and voice annotated text operations

These software packages can be operated through voice recognition with voice output, through the telephone keypad with voice output or through the IBM PC keyboard

## NETWORK FOR THE IBM PC

The MANAGER system adds a modem which can turn the PC into a telephone if a separate handset is added. The modem enables the MANAGER to receive unattended voice and data from any telephone in the U.S. or Canada. The MANAGER can accept commands by decoding the tones in the telephone keypad.

The EXECUTIVE is the most complete implementation of ELAN, adding computer recognition of spoken commands. An executive might phone the PC to leave or retrieve messages or request specific information. The PC, in a spoken voice, can request the user's access code or offer a list of options the user can select. The EXECUTIVE can then key in answers or commands with the phone's tone dialing buttons, or may simply speak his response to the computer.



## MANAGER \$1995<sup>1</sup>

- Ethernet Link
- Ethernet Companion
- Modem (300 Baud)<sup>2</sup>
- ELAN Software

## HARDWARE

### ETHERNET LINK

Permits communications between computers at extremely high speeds (10 Mbits per second). The transmission mode is through single video coaxial cable with easy-to-use BNC connectors.

### ETHERNET COMPANION

Performs the function of voice digitization and voice replay, dictation machine control and foot pedal control. Also contains interface for mouse.

### MODEM

**103 (300 Baud) \$295**  
**212A (1200 Baud) \$695**

- 103 (300 Baud) or 212A (300 or 1200 Baud)
- Pulse/tone automatic dialer
- Dual tone DTMF receiver (decodes touch tones)
- Auxiliary voice circuit
- Auxiliary, optically coupled, ring indicator output (capable of being used for auto power-on)
- Can replace telephone with the addition of a handset

### VOICE RECOGNITION MICROPHONE

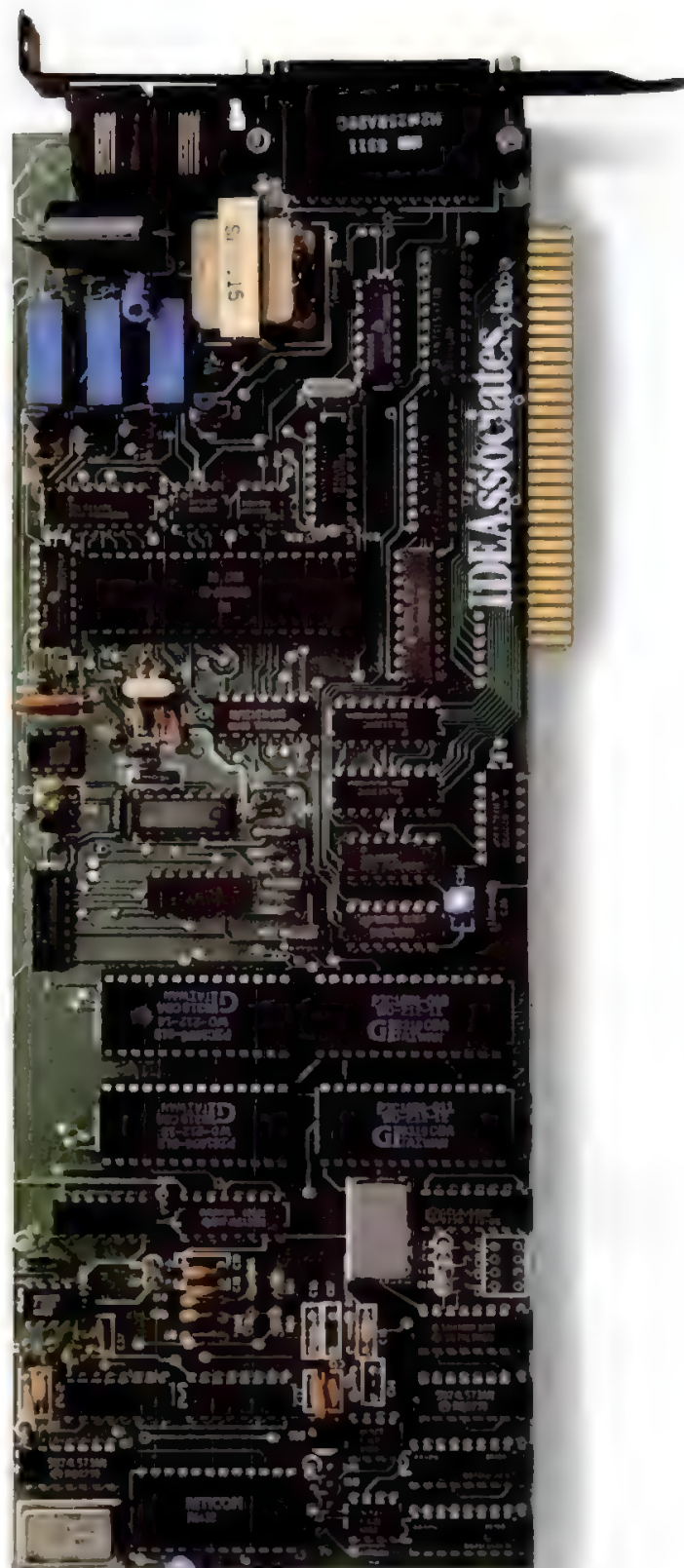
**\$995**  
**\$170**

User-dependent 100 word recognition (200 words optional) with 98% accuracy. Permits computer to respond to voice input.

**TECMAR**

Tecmar, Inc.

6225 Cochran Road  
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**Introduce your IBM-PC  
to a fast-talking card sharp.**



# The IDEComm 1200: Fast, reliable communications on a plug-in card.

Now you don't need an external modem to get 1200 baud communications capability for your IBM-PC. The IDEComm 1200 is an integral modem that combines the functions of an in-board asynchronous communications card and an out-board modem in one integrated plug-in unit. Snap it into an expansion slot, plug in a modular telephone jack, and you have direct 1200 or 300 baud communications without the confusion and added expense of external boxes and cables. And there are no switches to set; the speed is software-selectable or automatically selected by the card. Plus, we've designed in outstanding reliability: four powerful on-board microprocessors replace conventional analog circuitry with digital precision and reliability.

## One Card That's a Great Deal

The fast-talking IDEComm 1200 is one sharp card: it eliminates the need for an external modem, gives you 1200/300 baud communications capability with the exceptional reliability of digital design; provides an additional plug so you don't lose regular telephone voice communications; and includes a standard RS232C interface and connector that can be used as an additional serial port. All for only \$545. That's about the cost of a conventional external modem alone, saving you the entire cost of the internal asynchronous card.

## One Card Gives You a Full Hand

The IDEComm 1200 comes complete with software diskette enabling easy, menu-driven selection of all

communications, autodial, and auto log-on procedures, and easy recall at the touch of a single key. It also allows the IDEComm 1200 to work with most other terminal emulation packages—including IBM Comm 2.0 communications software.

## We've Stacked Our Deck With Better Ideas

IDE's Better Ideas for your IBM-PC include expansion memory boards, "The IDEABoard" combination boards, fixed or removable Winchester disk drives for either internal or external mounting, and printer spooler and RAMFloppy disk emulation software. We have Better Ideas on product support, too. Superb technical support and documentation, including full programming specifications for the IDEComm 1200 . . . an aggressive pricing policy . . . a unique upgrade policy that lets you trade up any IDE product for another in our line . . . and our full year warranty.

## Get the IDEA

To see IDE's Better Ideas for yourself, contact any of the knowledgeable dealers listed below. If there is no listing for a dealer near you, call us. We'll provide you with the name of your nearest dealer or take your order over the phone.  
**1-800-257-5027**  
(In Massachusetts, call 617-275-4430)



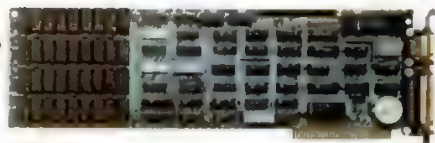
Removable Winchester disk drive



IDE Software



Expansion Memory Board



"The IDEABoard"

Technical Specifications	
<b>Speed</b> 0-300 bps or 1200 bps	<b>IBM Port</b> COM 1
<b>Data Format</b> Serial, binary, 7-8 data bits, 1-2 stop bits	<b>Modem</b> <b>Compatibility</b> Bell System 103 or 212A in both Originate and Answer mode
<b>Dialing Capability</b> Touch-Tone (TM) or rotary dial pulse	<b>Physical Data</b> 3.9" x 10.8" x .6" (one card slot)
<b>Operation</b> Full Duplex	

**IDE**  
**IDE Associates**  
Better ideas for personal computers.

IDEAssociates, Inc. 7 Oak Park Drive, Bedford, MA 01730

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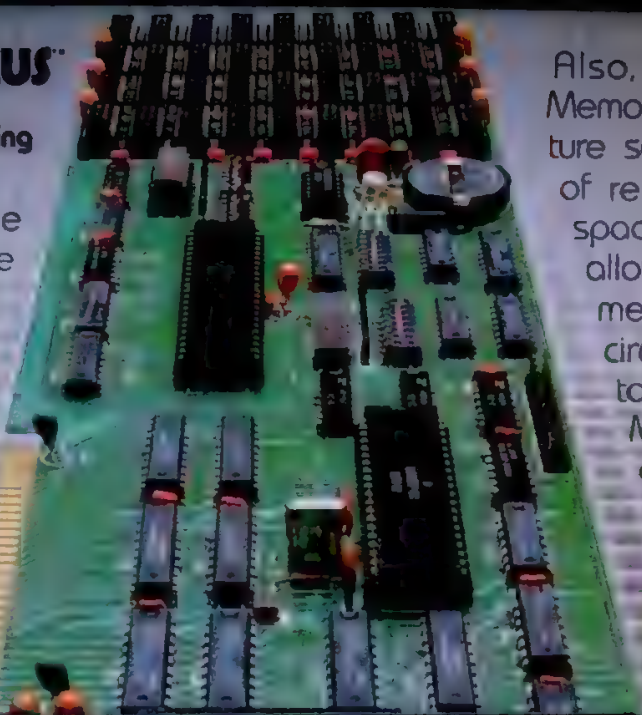
**A  
Million Bytes  
for Your  
IBM PC**

**REBATE!**  
The **256K CHIPS** are here.  
Ask about our rebate.

**RAMPLUS™**  
with  
Memory Mapping

To keep pace  
with new software  
and your increasing  
need for more user

memory, we designed  
the RAMPLUS™ multi-  
function memory board  
to accept either the  
64K RAM chips or the  
new 256K RAM. When  
the 256K RAM chips ar-  
rive, you'll be ready  
with RAMPLUS™.



Also, our exclusive  
Memory Mapping fea-  
ture solves the problem  
of reserved memory  
space in the IBM PC and  
allows you to use a full 1  
megabyte of RAM on one  
circuit board. We'll be glad  
to explain our Memory  
Mapping feature in more  
detail. Ask for Technical  
Note No. 2871-T.

See your dealer for orders and information  
about RAMPLUS and our other PC Com-  
puter Components — Combiboard™,  
Flexmem™, Digiboard™, Digiquad™,  
and Dynadisk™.

**RAMPLUS™ Multifunctions**

- 64K-256K expansion memory  
(expandable to 1 megabyte with 256K chips)
- Serial port - RS-232 compatible
- Parallel printer port - IBM hardware and software  
compatible
- Clock/calendar with battery backup

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Or contact us directly.

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CIRCLE 431 ON READER SERVICE CARD

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*The best consultants excuse themselves when they're not needed. To locate the best, be prepared: Ask lots of questions.*

# How To Choose A Consultant

You absolutely need a computer, right? Everyone else has one, so why not you? And you've seen those ads on television—the one where the poor guy with the 85 file cabinets full of accounts payable brings in a tiny desktop personal computer. He just presses a button and everything is fixed instantly, and it's time to head off for Aruba with the new blonde from personnel.

Maybe. But if your problems are that severe and your need that great, and if time and money are that tight, perhaps you should consider hiring a consultant.

"People who are confident and knowledgeable about what they want, or people who are looking for a computer to do applications like word processing or simple spreadsheet work, for which software is readily available, probably don't need help," said one computer consultant. "On the other hand, if you can't get the help you want in a computer store, or if your requirements are special, you should start

looking for a consultant."

PC Magazine spoke to two consultants who specialize in the micro and minicomputer field—We'll call them "Tom" and "Jerry."

Engaging a consultant, Tom said, can range from buying dinner for a knowledgeable friend to paying for an hour or two of office time (at a cost of perhaps \$200) to a full-blown analysis, proposal, purchase, and installation agreement, which could run several thousand dollars over and above the cost of hardware and software.

"If you're considering buying a PC, or more than one PC, that's \$5,000, maybe \$10,000 or more," Tom said. "A \$200 consulting bill is not out of line to make sure you get the right equipment, is it?"

Both consultants stressed, though, that the emphasis is too often on the hardware. In a custom installation, the cost of software can be two and three times that of the

hardware. It is, after all, the software that is the real interface between the user and the system. A consultant should be able to make that connection as "friendly" as possible by writing an original program, or adapting an existing one to your particular needs. Another advantage of customization may be the ability to "migrate" data from an existing system to your new system, or to set up your new system so that it may one day be upgraded.

"Anybody who can't find a software package that meets his needs, or who locates one but can't find out if it will do what he wants it to, should get some help," Jerry said. "For example, I would never install a full accounting system without a consultant."

## **Sending Out an SOS**

Consultants are not as easy to find as the neighborhood computer store. At least not yet. You may find some listings in the

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phone book, or you may find some suggestions from area retailers, hardware or software manufacturers or distributors, or through user's groups. But the most likely route is by reference from customers.

"You'll find a consultant the same way you find a lawyer or an accountant," Tom said. "Find someone who has used a consultant and seek a recommendation."

Once you've located one or more candidates, ask them for names of clients, too. "Be sure the reference he gives you is a valid one, without any bias," Tom said.

Educational and professional credentials are worth investigating. There are groups such as the Independent Computer Consultants Association (P.O. Box 27412, St. Louis, MO 63141), or the Data Processing Management Association (505 Busse Highway, Park Ridge, IL 60068) that may be of some help in making selections.

**YOU'LL FIND**  
*a consultant the same  
way you find a lawyer  
or an accountant.*

The most important thing, though, according to Jerry, is to ask, "Has this person done exactly the sort of work I'm looking for?" and "What do his clients say about his performance?" You should seek a face-to-face meeting with the consultant. "You've got to find someone who is very compatible with you," Tom said.

Jerry stressed the importance of concentrating on the consultant's attention to the details of your business. "Of course, what he knows about the technical side is important; but at least as important is what he knows about your business. And also, consider what he does after the initial meeting. Does he send you a memo confirming the details of your discussion, laying out what he can do for you, and including prices? He should be able to be very specific, because that is what you are looking for."

### Beginning to Consult

Your first conversation with the consultant should include a frank and clear

## The Independent Computer Consultants Association

*Help! A nationwide association that can offer assistance in finding a consultant.*

The Independent Computer Consultants Association, which represents more than 3500 consultants in 1100 companies across the country, can offer assistance in finding a computer consultant, according to Steve Epner, founder of the group. Local chapters can refer you to members, or the national office can try and help you directly.

"We do not allow as a member anybody whose major business is selling hardware or software," Epner said. "We define a consultant as an independent who provides advice to the public for a fee."

Epner offered a few words of free advice. "You should pick a consultant the same way you would hire a high-level employee," he said. "You're bringing somebody in to help you, and this person's actions may affect the financial viability of your company. If you were going to hire an executive vice president or a new president, you would go out and interview people, you would talk to references, you would look at what kind of work the candidates have done in the past. You should do the same kind of thing with a consultant."

According to Epner, checking references is an art. "No one is going to give you a bad reference. Let's start out by assuming that the consultant is halfway intelligent. You know that when you call, the reference is going to say that your candidate did a good job. What you want to say is, 'How did the person work? Did he like to hold meetings early in the morning? Was he always on time? Did he prepare neat reports or was everything done orally?' Find out whether the work habits of the consultant match those of the company."

The Independent Computer Consultants Association can be reached by writing: P.O. Box 27412, St. Louis, MO 63141.

—Karen Cook.



discussion of what you are proposing to purchase:

- Are you seeking advice on buying a system? You should establish the hourly rate the consultant will charge to analyze your needs, to draw up specifications, to make recommendations on sources, and for other services he will provide.

**WE DO NOT**  
*allow as a member  
anybody whose major  
business is selling  
hardware or software.*

- Are you looking for special services? Do you need help in drawing up a plan for internal review and approval? Do you want assistance in dealing with vendors?

- Are you looking for custom programming? You will be buying the consultant's time as an analyst, his (or his staff's) programming time, and the installation of the software and necessary training.

- Are you asking the consultant to provide a "turnkey" installation? In this case the consultant will do the analysis, make recommendations on hardware and software, adapt the software to write original code if needed, install the equipment and software, and train the users.

Fees for services are completely negotiable, with consulting work typically billed at a rate ranging from \$25 per hour to several hundred dollars per hour, depending upon location, the degree of expertise of the consultant, and the nature of service to be provided. Programming time is typically billed at about \$40 per hour.

You should also be clear on who will be working with you. Sometimes the person who makes the presentation is not the person who will be doing the consulting work. This is particularly true in larger operations, which may have staffers who specialize only in closing deals.

### Reducing the Price

"The more preparation you do before you walk in the door, the cheaper it will be

to walk out," said Jerry. Bring as much raw data as you can collect: the number of files, the number of users, dollar volumes, the number of pages of word processing or printing, the types of forms involved, the sort of information you need to collect or analyze. If the consultant has to pry this information from you or your staff, or if he has to count the files himself, "it's like paying the taxi to wait," Jerry said.

Another factor you should consider is the amount of time the consultant will require of you and your staff. This is a sometimes overlooked expense, and one that should be weighed in your decision making. Is it cheaper to use your resources or those of the consultant?

This sort of decision is particularly important when setting up a database or other applications that may require the conversion of noncomputerized files. "Don't pay a consultant \$10 per hour to have him hire someone to enter data, if you can have it done for \$3.50 per hour," Jerry said.

### Buying Hardware

The consultant might offer to sell you the hardware and software as well as giving advice. This is an area where you'll have to make a judgment: Do you believe the consultant is fairly representing your interests?

**NO ONE IS**  
*going to give you a bad  
reference.*

Buying through the consultant should not increase your costs, by the way. In fact, some consultants are able to offer discounts from list price. Like a travel agent or an interior decorator, the consultant typically receives a commission from the seller, not the buyer. The seller may be a retail operation or it may be the manufacturer or distributor, and the commission can range from one-third to one-half of the list price.

"The money for a consultant is not in the hardware sale," said Tom. "I don't want the price of the computer to come between me and my client. My income

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comes from the consulting side."

Along the same vein, Tom suggested that the consumer not tie the hardware purchase to the cost of consulting. Treat each element separately to get the best deal—and maintain the best relationship.

### The Consultant as Shopper

Some people who know what they want—either as the result of their own investigation or after consultation—will hire a consultant as an expert on shopping.

"I've had people ask me to go to stores with them," Jerry said. "In fact, I went to one store as my client. I had the salesman try to sell me a multi-PC system with non-existent software. I went back and told my client to forget that guy."

Another service a consultant might provide is to assist you in obtaining service on hardware or software. Of course, if you buy hardware from a consultant, he is usually obligated to service it during a warranty period, but you may be able to

get your consultant to arbitrate between you and a manufacturer for any equipment or software you own.

### Striking the Bargain

When you've decided to engage a con-

**C**ONSULTANTS' wives have it no better than doctors' wives.

sultant for anything more than a few hours of conversation, you should take the time to get a statement in writing of the work to be done, together with a formal legal contract outlining duties, full specifications, responsibilities, and charges. The contract should state all of the following:

- Who will own the finished software? (You might be better off leasing or renting

software which usually ensures technical support, rather than purchasing it outright. Such an arrangement may also offer you tax advantages. On the other hand, if you want to own software outright, make certain your agreement states that as a condition.)

- Who will maintain software and hardware?

- Will the consultant be on call to help with emergencies or ordinary problems? For what period of time? Will there be additional charges?

- What kind of warranties are offered on the software? On the hardware?

- What kind of training will personnel be given? Will refresher courses be offered at a later date? How about new courses for new employees? At what cost?

Some companies have found it to their advantage to place a consultant on retainer, guaranteeing access when needed. Such an agreement should also be spelled out in advance.

"I've been tracked down by clients while I was on a vacation," Jerry said.

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"I've gotten calls in the middle of the night. Consultants' wives have it no better than doctors' wives."

Both consultants recommended that you not pay for a full package of services in a lump sum. Payment should be spread out over the course of the agreement, based on agreed-upon milestones. For example, portions of the bill could be paid on completion of an analysis, drawing of specifications, delivery of equipment, installation of software, and completion of training.

Believe it or not, both Tom and Jerry said they had at one time or another sent away a client without a computer.

"I had a Broadway casting agent ask me for help," Tom said. "He had thousands of index cards with information about actors and he wanted a computer cross-reference. I figured out it would cost him 30 cents to a dollar for each card transferred over to the computer, while throwing the cards in a file cabinet was free. His budget couldn't stand it."

"I have a friend with a drugstore," he

continued, "who set up to record every transaction on a micro. It worked out well when he went home every night and recorded them on the computer himself. But he wasn't making any more money for finding his customers' files faster. His

## **P**AYMENT *should be spread out over the course of the agreement.*

computer didn't bring him an extra dollar in revenue."

"You have to look at the payback. If you can't answer basic questions on total cost and return on investment, then you need help, and you need to listen to a consultant's advice."

There are also clients who have wasted money, even with the assistance of a consultant. "There's one client I had who was so thick-headed and obstinate he refused to learn to use the computer," Jerry said. "I'm sure his \$10,000 system is just sitting under a desk somewhere today."

If you are to believe all of the advertisements for computers and software, the days of the microcomputer consultant would seem to be numbered. Are consultants on their way to obsolescence?

"IBM took the Little Tramp and said, 'This is Everyman's Computer.' The PC raises everyone's expectations," Tom said. "It makes some things very simple. But you still can't press a button that says 'sort.'"

"The day when any of the program generators really work, and the day when computers are so cheap you can throw one away if it doesn't do what you want it to, consultants will be on their way out," he continued. "That's already coming in hardware, but software is not there yet."

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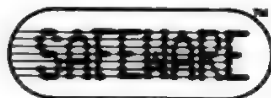
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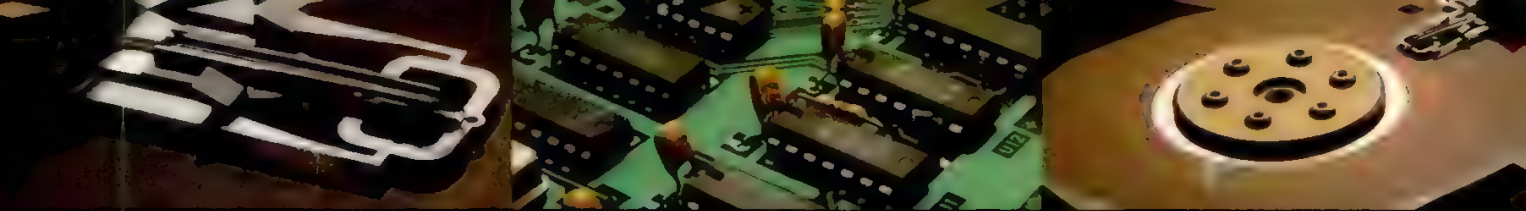


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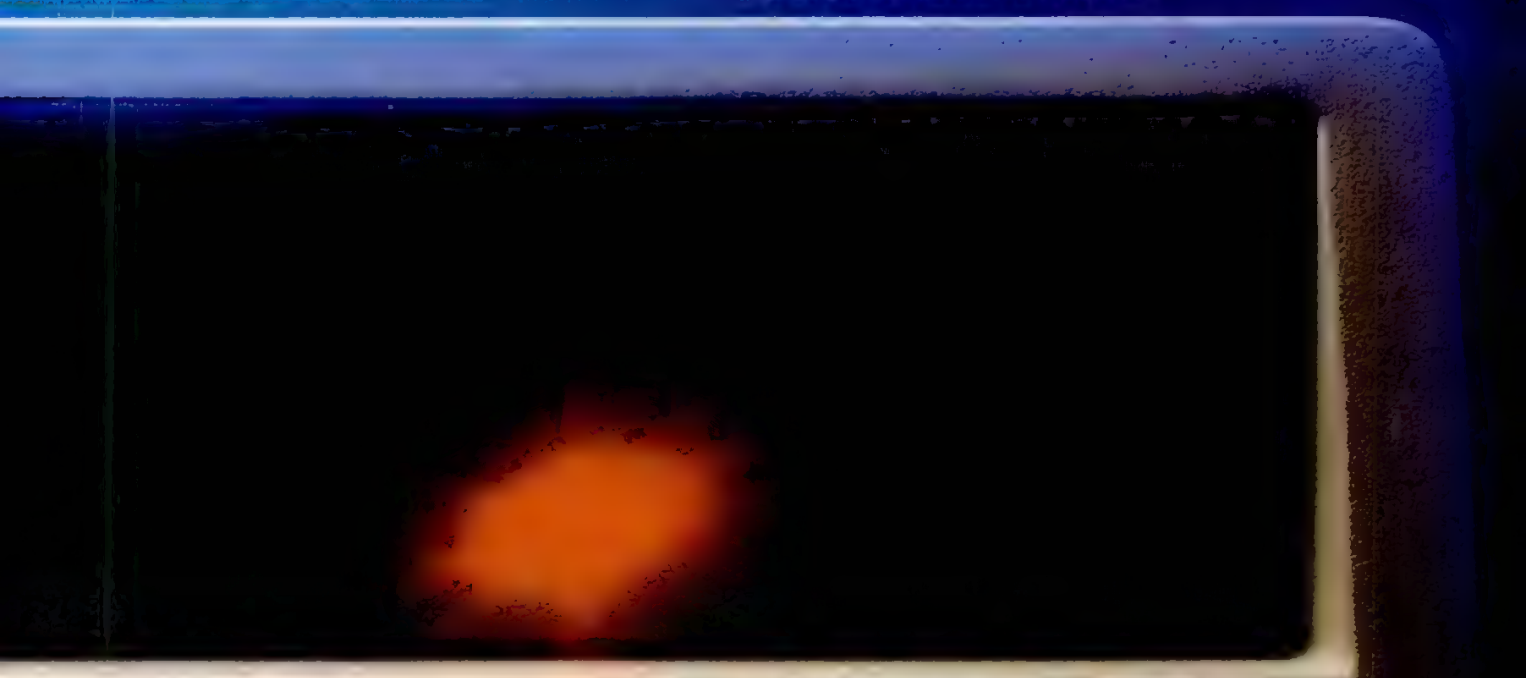
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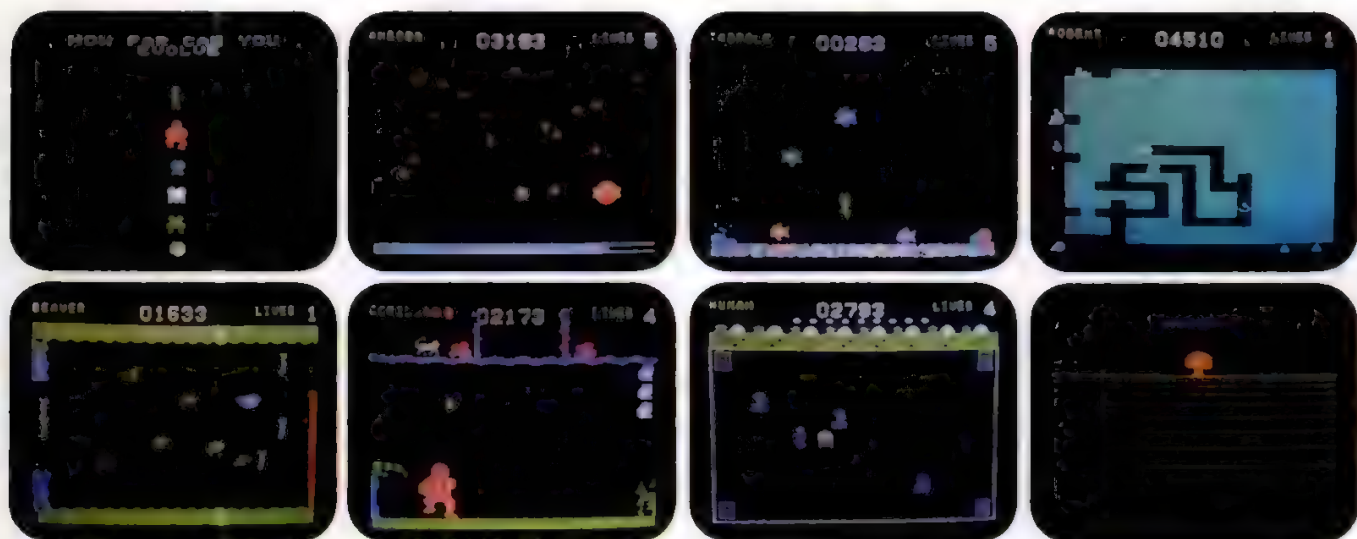
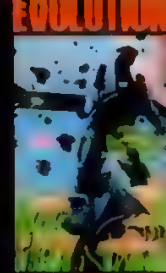
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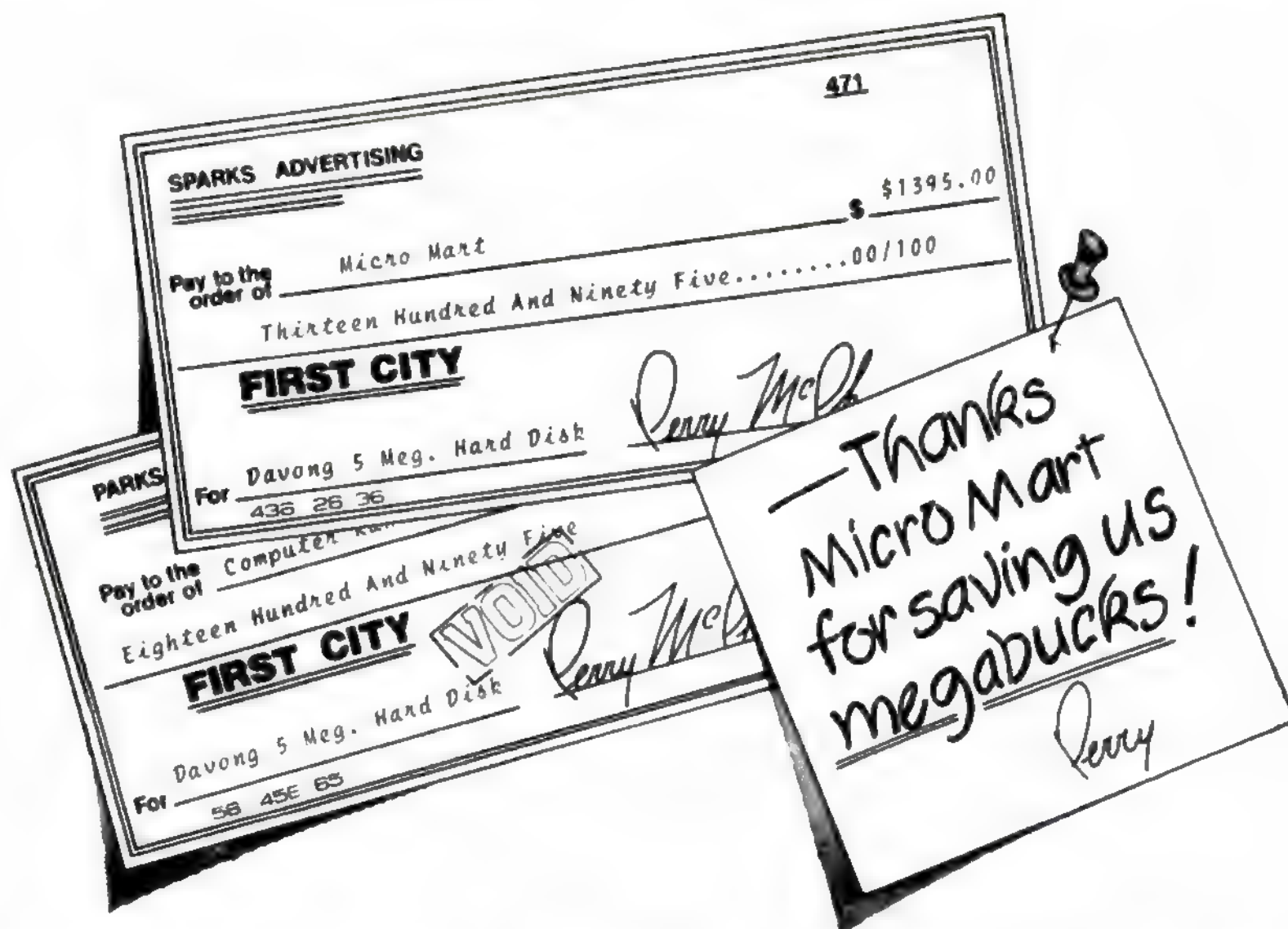
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puzzles in your own imaginary landscape and watching people wrack their brains over the solutions.

Most of the larger text adventures are written in assembly language for the sake of speed and space conservation. A "large" game is one that has over 200 room locations and over 50 objects. If a game isn't too large, and if speed isn't too much of a consideration, it can be written in any other language—including BASIC.

My own adventure games are built

from two basic parts: the driver program and the text files or "script." The script contains all of the vocabulary words that the driver recognizes, plus the object and place descriptions. There is also a builder program that converts the text in the script to machine-readable tables. Because the games are script-driven, I can build 70 to 80 percent of a new game without ever touching the actual program source code.

The mechanism of the games is rela-

Figure 1: The vocabulary list for the author's adventure game, The Phantom's Revenge. Subsections classify the permitted words as motion verbs, objects, action verbs, function words, and adjectives.

SEC01	VOCABULARY - The Phantom's Revenge
SUB01	MOTION VERBS
1	LOOK DESCRIBE
2	CAVE CAVES
3	BACK RETURN RETREAT OUT LEAVE EXIT
4	NULL WAIT
5	UPWARD UP U CLIMB ABOVE ASCEND
6	DOWN DOWNWARD DESCEND D
7	LEFT L
8	RIGHT R
9	ACROSS
10	EAST E
11	WEST W
12	NORTH N
13	SOUTH S
14	NORTHEAST NE
15	NORTHWEST NW
16	SOUTHWEST SW
17	SOUTHEAST SE
18	ENTER FORWARD ONWARD INSIDE
19	ERIC
20	CHRISTINE
21	FANTOME
22	HAM
23	JUMP
SUB02	OBJECTS
1	KEY KEYS
2	LAMP LANTERN
3	BARS
4	TICKET DUCAT PASS
5	WHISKBROOM WHISK BROOM
6	SHEETMUSIC MUSIC SCORE SONG
7	RAFT FLOAT
8	DOG HOUND POOCH ROVER BOWSER CANINE
SUB03	ACTION VERBS
1	CARRY TAKE KEEP CATCH STEAL CAPTURE GET
2	DROP RELEASE FREE DISCARD DUMP
3	SAY CHANT UTTER MUMBLE



tively simple. Objects, room locations, messages, and command words are identified by number. The driver program accepts a phrase of text as input and parses it. The code number for each recognized word is stored in a variable. These numbers are then used to access tables, retrieve messages, and provide program branch points. All of the objects in the game have "states." It is the control of these states that allows the player to solve puzzles, move things around, etc.

The parser is one of the most important parts of the program. It is the most visible section of the code, since it evaluates the player's input and displays the "intelligence" level of the game. When you set out to write a parser, you enter the whole complex world of artificial intelligence. Fortunately, adventure games take place in a confined universe, such as a set of caves, where the author can control the objects and the actions. Thus, they can have a limited vocabulary of specific

```

4      UNLOCK
5      NOTHING
6      LOCK
7      LIGHT ON
8      EXTINGUISH OFF

SUB04  SPECIAL VERBS
50     SESAME OPENSESAME ABRACADABRA SHAZAM
51     HELP
64     TREE TREES GROVE
66     WAVE SHAKE SWING
68     LOST
69     OPERA
79     HELL DAMN
115    PET STROKE PAT
139    STOP

SUB05  FUNCTION WORDS
1      YES Y
2      NO N
3      TO INTO IN AT TOWARD ON UNDER ATOP INSIDE
4      FROM
5      ALL
6      WITH USING
7      AND THEN
8      AN AN THE
SUB06  ADJECTIVES
1      BIG LARGE HUGE ENORMOUS VAST
2      SMALL TINY WEE ITTYBITTY
3      LIGHT WHITE
4      DARK BLACK
5      RED VERMILLION CRIMSON
6      GREEN
7      BLUE AZURE
8      ORANGE
9      YELLOW
10     PURPLE LAVENDER VIOLET
11     NEW
12     OLD
    
```

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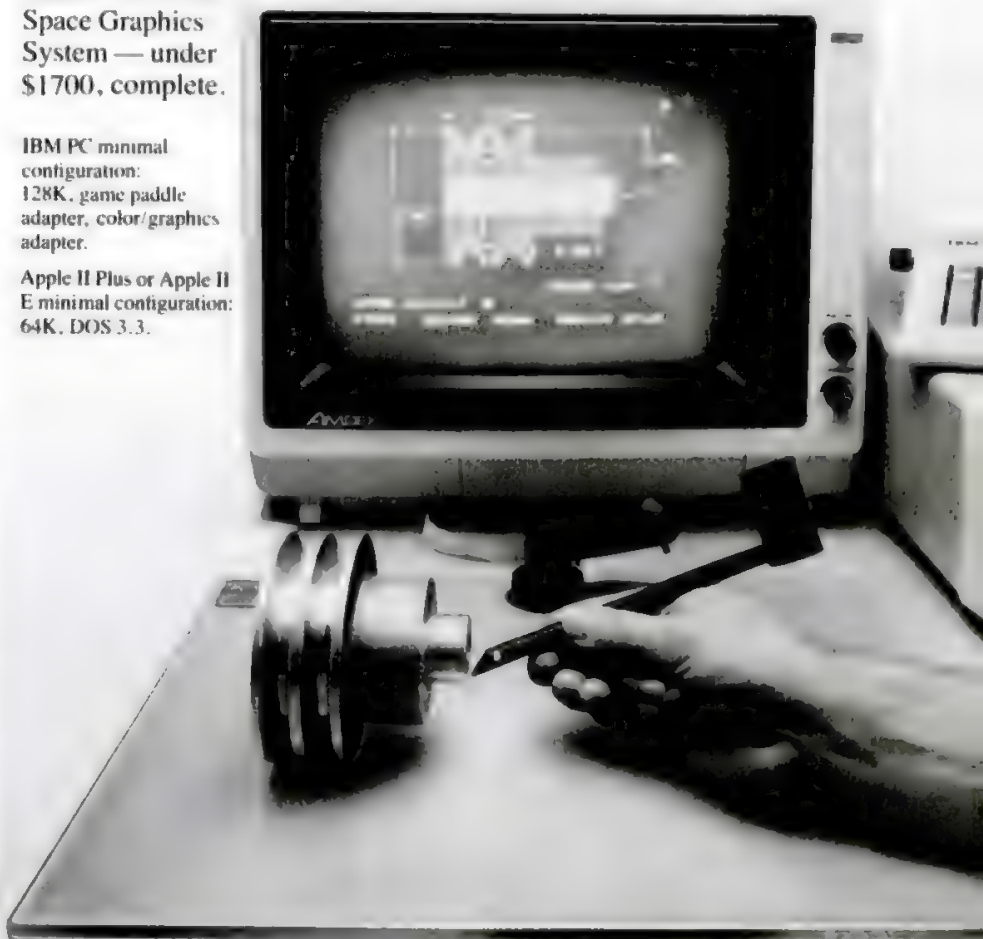
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words.

Because of this limitation, it is possible to read each word that the player types in, locate it in a table, and decide what to do with it. The simplest parsers only accept a two-word input, consisting of a verb and an object: TAKE BALL, EAT FOOD. Each word is tested against the internal tables.

---

**I**F ONE word is found, but the other can't be identified, an error message is displayed that includes the one word that the parser was able to identify.

---

If no match is found for either word, the player gets the error display "What?" If one word is found, but the other can't be identified, an error message is displayed that includes the one word that the parser was able to identify: "What do you want to do with the BALL?" or "EAT what?"

This method requires the program to identify a word as a noun or a verb. In BASIC, one approach would be to set up a noun array and a verb array. To create vocabulary tables in BASIC, you would dimension them with DIM, and enter the vocabulary words with DATA. During game play, a subroutine would be called to validate the input word and store its number in a variable.

The parser I use is a little more elaborate. It can accept an input sentence of up to ten words and identify a verb, direct object, and indirect object. Either the direct object or the indirect object can be described by adjectives to distinguish them from other objects in the same place.

For example, if the parser read, "PUT THE RED BALL IN THE LARGE BOX," it would identify PUT as an action verb and place its internal verb number in a variable called VERB. It would then check to see if any object present could be described as a RED BALL and, if so, put its

internal object number in a variable named OBJ. (Since the vocabulary list shows synonyms, the parser would reach the same result if the player typed CARMINE SPHERE instead of RED BALL.) Finally, the parser would identify LARGE BOX as the indirect object and return its value in the variable named INDOBJ.

Figure 1 shows part of the vocabulary list for one of my games. As you can see, the list is divided into subsections, depending on the word types: motion verbs, objects, action verbs, special verbs, function words, and adjectives. (LOOK and CAVE are listed with motion verbs but are actually handled as special cases. LOOK repeats the room description, and CAVE displays two different informational messages, depending on how far into the game the player has gotten.) This data structure lets me use any word I want as a movement word. The last six words in SUB01 are "magic" words that only work in certain places, but they are nonetheless motion verbs.

SUB04 contains words that have no effect on the game, but return a special message when the player enters them. The numbers in the first column refer to the messages, which are retrieved from a separate table.

There are really only two types of input in an adventure game. The player can enter a movement request or an action request. Once the input has been parsed, the program can deal with the request.

A movement request is made by typing in a direction, such as WEST, NE, or SOUTHWEST. The driver program reads a location code variable (LOC) for the player's current location, and then goes to a table to read the allowable move com-

mands for that room. If the move is legal, that is, one that can be found in the script, the player's location code is updated and the description of the next room is printed. If there is an object with the same location code as the room, the object description is printed too.

---

**I**F THE move is legal the player's location code is updated.

---

I control movement in my games by percentage, by object state, by whether the player is carrying a particular object, and by specially coded controls that do more elaborate checking. Figure 2 shows some sample movement controls. In all cases, the first column contains the number of the player's location. The second column can be the number of the room he will "move" to, a message number, a special routine number, or even a command to issue a message and "kill" the player.

The third column is a restriction on the move. If there is no entry, the move is unrestricted. The last column contains the words that the player has to enter to make the move. Multiple entries in this column mean that any one of the words shown will have the same effect.

Suppose that the player is in room number 81 and types EAST. The driver reads the file and sees that EAST is an allowable direction from room 81. If the player types EAST, he will go to room 82. Ah, but the next column shows that there is a condition on the move. N0=9 means that the movement cannot take place if object number 9 (which happens to be a door) is in state 0 (closed). If object 9 is in state 0, the driver then reads the next line, which tells it to display message number 10, "You can't walk through a solid door!"

If object 9 is in state 1 (open), the player can "GO EAST." The driver moves 82, the room number, to a variable called LOC, which is the player's current position, and uses that number to fetch the messages describing room 82 and any objects at that location.

Figure 2: The movement control file for Elsinore, a game by the author based on Hamlet.

81	82	N0=9	EAST
81	M=10		EAST
81	K435		WEST JUMP
82	81	C=4	DOWN
82	M=47		DOWN
82	83	50%	SOUTHWEST
82	123		SOUTH
82	203	S5	UP
82	82		NORTH EAST



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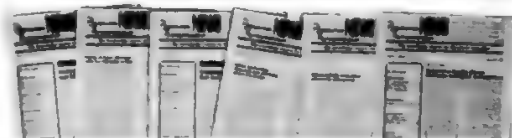
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Line 3 of Figure 2 includes K435 in the second column. This means that if the player is in room 81 and types WEST or JUMP, the driver will issue message 435 ("You have just jumped off of a 50-foot cliff.") and "kill" the player.

**I**FA  
*player types TURN THE  
CANNON, the driver  
first verifies that TURN  
is an acceptable verb  
and that CANNON is a  
recognized object.*

The fourth and fifth lines of Figure 2 show another move restriction. C=4 means that the player must be carrying object number 4 to make the move. If he doesn't have that object with him, the driver issues message 47 ("You can't go in there without your ticket.")

The next two lines show how percentage is used to control movement. If the player types SOUTHWEST, he will move into room 83 50 percent of the time. (A random number subroutine is called to establish the pass/fail result.) If the player's move fails, the driver reads the next line—which is unrestricted—and moves him to room 123. This is the room he would have reached if he had typed SOUTH.

The eighth line of Figure 2 instructs the program to use special routine number 5 if the player is in room 82 and types UP. This particular routine involves checking the player's weight load to see if a rope ladder will support his weight. The last line of the figure shows an unrestricted movement that returns the player to his starting point.

Action requests are parsed like movement requests, but the driver goes to a "jump table" to find the code to handle the action. For instance, if a player types TURN THE CANNON, the driver first verifies that TURN is an acceptable verb and that CANNON is a recognized object. It then reads the jump table for the location of the TURN code and executes it.

Action is performed by changing the state and the location of an object. For example, the CANNON mentioned above is part of a puzzle where the player must load the cannon, turn the cannon to face a door, and then fire it to break the door down to allow entry to the next room. There are three objects to deal with—the cannon, the cannon ball, and the door. Each one of these objects has different states, and there is a different message for each state.

The cannon can be turned toward the sea (state 0) or toward the door (state 1). The cannon ball can be unloaded (0), loaded (1), or fired (2). The door can be intact (0) or smashed (1). You may think that it is peculiar to refer to the loaded/unloaded state of the cannon ball, but remember that a set of states was already used for the cannon itself.

The first step in solving this puzzle is to load the cannon. The player types LOAD THE CANNON, and the driver checks whether he is in the same place as the cannon, whether he has the cannon ball, and whether the cannon ball has been fired.

Each object in the game has a location code that's handled the same way as the one for the player. If the location codes for the player and the object match, then the object is considered to be in the same place as the player. (An arbitrary location code of -1 is assigned to objects that the player is "carrying.") In the program listing (Figure 3), LOC is the player's location, OBJLOC is the object location array, OBJSTATE is the object state array, 25 is the cannon, and 26 is the cannon ball.

**O**NCE  
*again the great hunter  
faces danger with an  
unloaded gun!*

The first six lines check the required states and locations, insert the message numbers for errors and branch to the error-handling routines. Error messages 101 and 102 are global messages, with the name of the object inserted: "There is no



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CANNON here!" and "You haven't got the BALL!" Error message 455 is from the specific message table, and says "The CANNON BALL is too mangled to fit in the CANNON."

If there are no errors, the program changes the location of the cannon ball from the player's inventory to the current room number and sets it to state 1. Message 50 ("The CANNON is now loaded with a 20-pound CANNON BALL.") is selected, and the program branches to a general routine that displays the message and waits for the next input.

If the player decided to pick up the cannon ball again (TAKE CANNON BALL), the logic would be reversed. The

state of the ball would be changed to 0, and its location changed to show that the player is carrying it.

The next step in this puzzle is for the player to swivel the cannon around to face the door. The correct input is TURN THE CANNON. The cannon only has two states—facing towards the sea or the door. When you use the word TURN, the program flips back and forth between them.

In Figure 4, message 62 says "The CANNON is now aimed out to SEA," and message 63 says "The CANNON is now aimed at the DOOR." The code at line 8000 is the same general message handler used in the first example.

Now that the cannon is loaded and

turned toward the door, it can be fired. If it isn't loaded, and the player types FIRE THE CANNON, he will get a sarcastic message: "Once again the great hunter faces danger with an unloaded gun!"

As you can see from Figure 5, if the cannon is fired when it is aimed out to sea, the cannon ball will be moved to a location along the beach, set to state 2 so it can't be used again, and the player gets a message telling what happened. If the cannon is aimed at the door, the cannon ball is still set to state 2, but it is moved to the room on the other side of the door, and the door itself is set to state 1. The message in this case says "KA-WHAM!" The CANNON BALL hits the DOOR and smashes it to bits." Look at lines 1 and 2 of Figure 2 to see how this state change is used to control movement in the game.

I use location 0 for a sort of Never-Never Land, where objects go when the player can no longer use them. Instead of setting the cannon ball to state 2, I could have set OBJLOC(26) = 0 and merely put out a message saying that there was a big splash as the ball hit the ocean and vanished. Either way, the player isn't allowed to fire the cannon again.

Messages for the different object states are stored in a separate table, built from the script. Each time the player goes to a new location or types LOOK (to request a description of the room he's in) the driver checks for objects at that location. If an object is found, the driver checks its state and displays an appropriate message.

Text adventures can be as complex as you care to make them. To avoid total frustration, start by writing a simple game and add to it as you go along. The theme can be anything from deep space to high-rise apartment living. You can have dragons, dinosaurs, aliens, or Little Bo-Peep. You can use your adventure as a tool to teach everything from the Bible to nuclear physics. Whatever direction you go with this idea you can have a lot of fun. /PC

Dian Crayne is the author of several adventure games published by Norell Data Systems: *The Phantom's Revenge*, *The Hermit's Secret*, *Monster Rally*, *Valley of the Kings*, and *Elsinore*. She has been a programmer/analyst for 10 years. Her science fiction writings are published under the pseudonym Dian Girard.

Figure 3: BASIC program listing of a routine to LOAD THE CANNON in Elsinore.

```
2000 IF OBJLOC(25) = LOC THEN GOTO 2020 REM cannon here?
2005 INSERT = 25
2010 OBJERR = 101 : GOTO 10500 REM issue error message & exit
2020 IF OBJLOC(26) = -1 THEN GOTO 2040 REM player has ball?
2025 INSERT = 26
2030 OBJERR = 102 : GOTO 10500 REM issue error message & exit
2040 IS OBJSTATE(26) = 0 THEN GOTO 2060 REM cannon ball available?
2050 ERRMSG = 455 : GOTO 10600 REM issue error message & exit
2060 OBJLOC(26) = LOC REM take ball from player
2070 OBJSTATE(26) = 1 REM set ball to loaded
2080 MESSAGE = 50 REM msg - cannon is loaded
2090 GOTO 8000 REM display message and continue
```

Figure 4: The TURN THE CANNON program segment from Elsinore.

```
3000 IF OBJSTATE(25) = 0 THEN GOTO 3030 REM cannon aimed at sea?
3010 OBJSTATE(25) = 0 : MESSAGE = 62 REM no, set it = 0
3020 GOTO 8000 REM issue message & exit
3030 OBJSTATE(25) = 1 : MESSAGE = 63 REM yes, set it = 1
3040 GOTO 8000 REM issue message & exit
```

Figure 5: The FIRE THE CANNON program segment from Elsinore.

```
3080 IF OBJSTATE(26) = 1 THEN GOTO 3100 REM cannon ball loaded?
3090 MESSAGE = 365 : GOTO 8000 REM no, issue msg and exit
3100 OBJSTATE(26) = 2 REM set cannon ball = "used"
3110 IF OBJSTATE(25) = 1 THEN GOTO 3040 REM cannon aimed at door?
3120 OBJLOC(26) = 6 REM move ball to seashore
3130 MESSAGE = 64 : GOTO 8000 REM issue message & exit
3140 OBJSTATE(9) = 1 REM set door to "smashed"
3150 OBJLOC(26) = 82 REM move ball to scholar's room
3160 MESSAGE = 65 : GOTO 8000 REM issue message & exit
```



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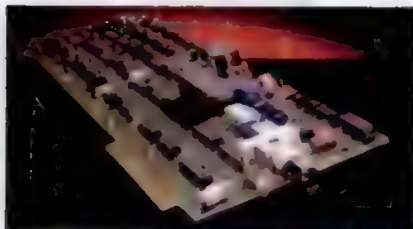


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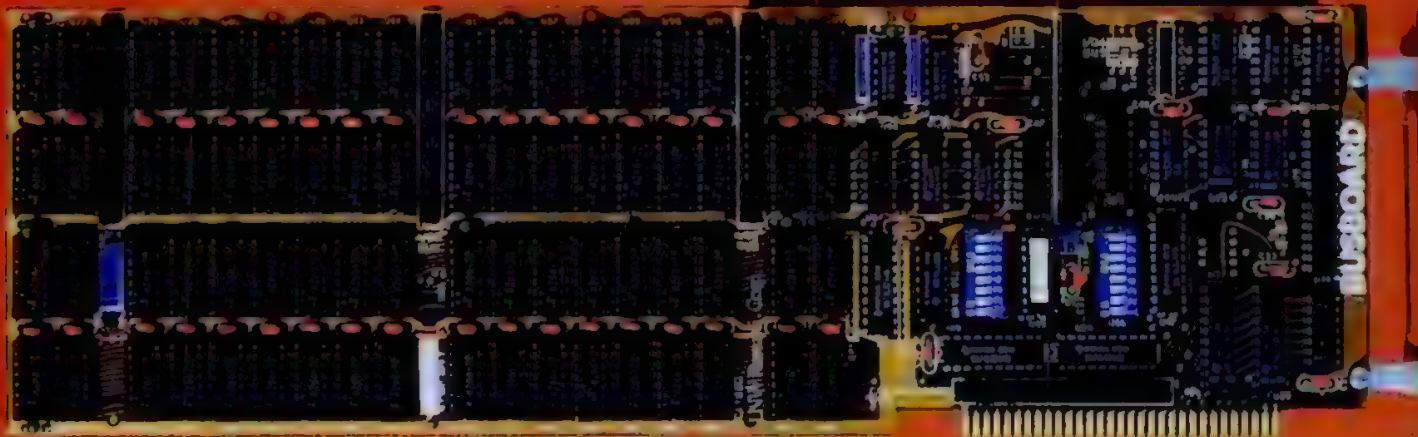




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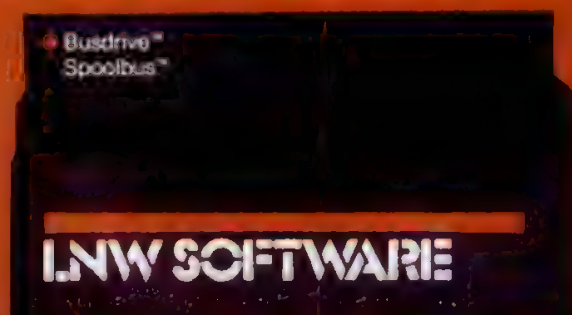
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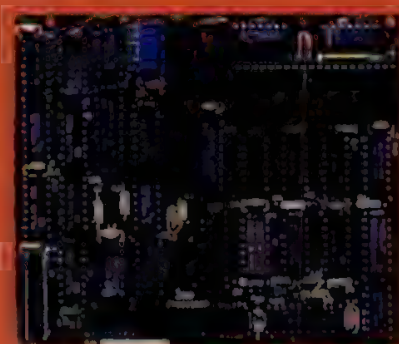
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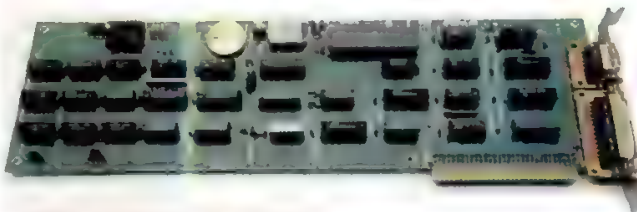
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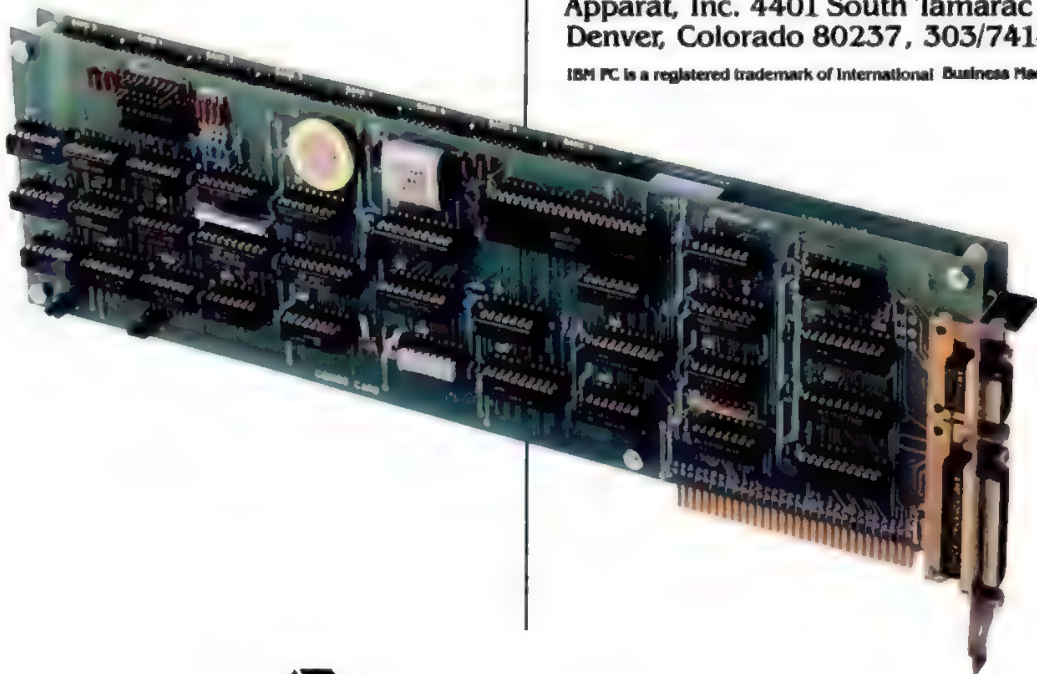
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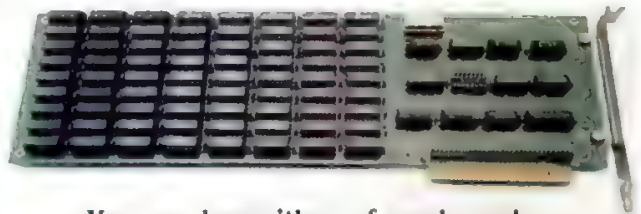
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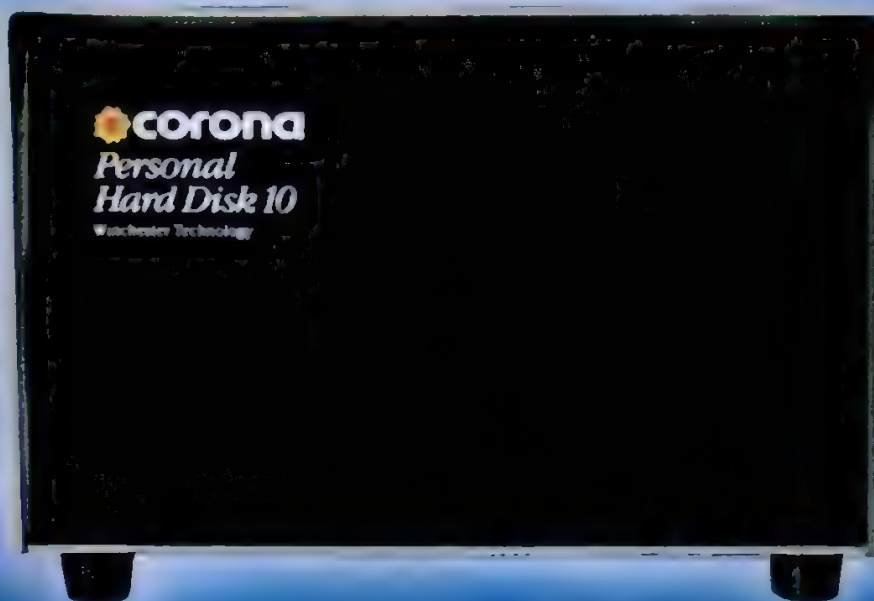
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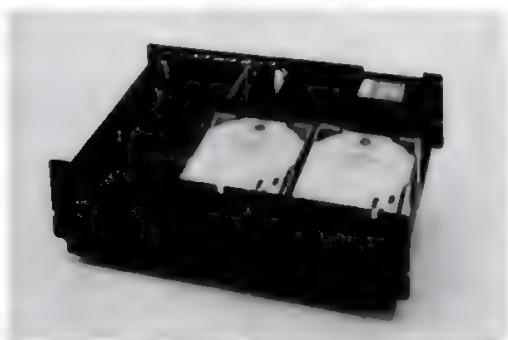


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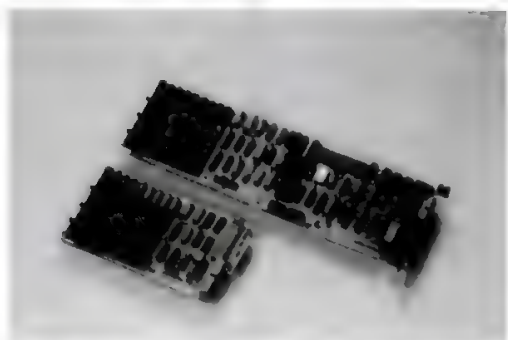
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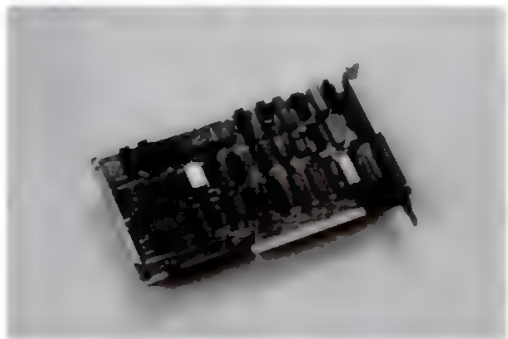
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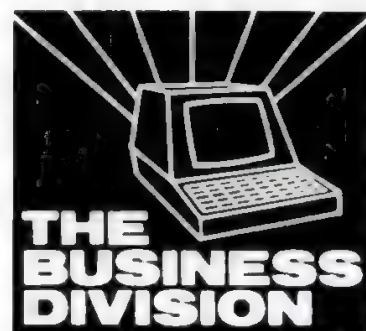
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# Launching The Disk (Magazine): We Have Lift-off

It had to happen: With all of the computer magazines vying for your attention, now there's a magazine for your computer to read. PC Disk Magazine's premier issue appeared in computer and bookstores in mid-August. The product, as its name implies, uses a magnetic disk instead of ink and paper to convey its message. The first edition includes 11 ready-to-run programs for PC computers, together with a complete manual.

It represents, according to its designers, an entirely new way for authors to reach the owners and users of the IBM PC. "This is not a magazine on diskette," said Editor Morris Efron. "The printed page is still the best way to convey information for human eyes. The point of PC Disk Magazine is to convey software in the easiest, quickest, and most efficient manner possible."

The monthly PC Disk Magazine was developed by Ziff-Davis Publishing, publisher of PC Magazine and many other popular "conventional-format" magazines devoted to computer users. The first issue had a press (and disk) run of 20,000 copies which will run on any PC or PC-XT or compatible machine with at least 64K,

with PC-DOS 1.1 or 2.0, and one disk drive (single- or double-sided). The magazine sells for \$29.95 at computer and bookstores (\$119.95 for a six-issue mail subscription).

"We took a good, long look at the soft-

ware on the market for the IBM PC, and at the means of distributing that work to the user," Efron said. "One of the things we found was that the less-expensive programs—no matter how worthy—often were not reaching their markets. We look



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at the Disk Magazine as one way for small programs—works that might not otherwise achieve commercial success—to be packaged together, duplicated, and distributed as a unit,” he said. “We can all

## **D**ISK Magazine will include long programs that could not be listed in print, and our software will be debugged and ready to go.

share the tremendous costs of production.

“This way the product is out there, and the author can make some money,” Effron continued. “And the user receives a similar benefit: a collection of programs that may be worth more than the sum of its parts.”

### Reader Contributions

The magazine will actively seek contributions from readers for upcoming issues. For details concerning submission, send for the “Software Submission Plan,” PC Disk Magazine, Dept. 732, One Park Avenue, New York, NY 10016. Authors are paid on a per-copy royalty plan, based on sales. “We want our readers also to be our authors,” Effron said. “They will determine the content and the success of the magazine.”

Effron predicted that the product will appeal to software companies with smaller pieces of software to offer. He noted that the utility by Peter Norton, which is included in the premier issue, is an offshoot of the well-known Norton Utilities, and the bar charting program is an adaptation of work by James Toussignant of Mirror Images Software.

“We purposely left the disk in source code and without copy-protection,” Effron said. “We want our readers to look at each of the programs included and learn how they work, and we want to make it easy to modify the software for individual needs.”

The first issue includes the following programs.

- **Disk Map**, by Peter Norton. This utility displays a complete map of any diskette, and can be used in file management and as an educational tool.

- **Loan Analyzer**, to evaluate alternative fixed-payment mortgage and loan agreements.

- **Automatic Bar Charter**, to produce graphs on screen or on a printer.

- **WordStar Configurator**, a menu-driven utility that configures many of the operating features of the popular word processing program.

- **IBM Matrix Printer Control**, to allow easy selection of special printing features including boldface, italics, and more.

- **BASIC Program Editor**, a full-screen editor for source code, including the ability to split screens to display two separate segments simultaneously.

- **Hide and Sink**, a battle game on the high seas.

- **Pyramid Match**, a game of memory and reflexes.

- **Personal Cash Flow Manager**, the first of a three-part system for the maintenance and reconciliation of as many as four checking accounts.

- **Perpetual Calendar**, a utility that can determine the day of the week for any date and the number of days between 2 dates.

- **Demographic Data File**, containing state-by-state information from the 1980 Census.

“The purpose of the Disk Magazine is not to supplant PC Magazine,” Effron said, “but rather to complement it. We’ll be able to include long programs that could not be listed in print, and our software will be debugged and ready to go.”

Similarly, Effron said, the package will not be in competition with the major software products in national distribution. “Our programs will complement these packages as well,” he said. Effron noted the inclusion of a WordStar utility in the first issue, and said he expected such products as dBase II coding or VisiCalc templates to be in future editions.

Plans for the second issue include another disk utility from Peter Norton, the second part of the Personal Cash Flow Manager, a data file that cross-references zip codes, telephone area codes, and Postal Service state codes, a data encryption program, and two games. /PC



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*Look at any software bestseller list and you'll see Microsoft hugging the top of the chart. PC visited MS Product Manager Tandy Trower to find out why.*

# The Microsoft Touch

Nosing your way up I-5 to the Bellevue, Washington home of Microsoft, you pass what is left of Mt. St. Helens. A few years back, this majestic, long-silent dome popped its cork and put the drizzly Pacific Northwest momentarily on the map.

But there's been an even bigger explosion a hundred or so miles upstate. Microsoft was the brainchild of two local boys who made very, very good: Bill Gates and Paul Allen. These two wrote the BASIC for the first microcomputer ever produced, and have dominated the field ever since. Their operating system, MS-DOS, has dethroned CP/M as the industry standard. Their BASIC hums merrily away on over one million micros, and their many other languages are scratching out footholds among advanced users. And their lesser

software, such as the MS Flight Simulator and the MS/IBM Typing Tutor, has cash registers jingling coast-to-coast.

PC wanted to learn more about Microsoft's past language successes and future language plans, and spoke at length with Tandy W. Trower, Product Marketing Manager of both business and consumer products. Trower is responsible for all of Microsoft's language, educational, and recreational software.

The following conversation took place in Microsoft's offices on the outskirts of Seattle, a bustling metropolis whose cars sport bumper stickers crowing "I ♥ Seattle—the Emerald City." Seattle is about as far away as you can get from Boca Raton and still vote. But it was a nod from IBM—the rabbi's kosher seal of approval—that

ensured Microsoft's preeminence. And sent this reporter winging west.

**PC:** Does Microsoft sell very many nonlanguage, non-operating system products?

**Trower:** We don't do too many products in that area. What Microsoft looks for in those areas are other classics like Flight Simulator or Decathlon that have done extremely well for us. Although we didn't author the original version of Adventure, the adaptation we did for micros has done extremely well. In fact it has done much better than I expected on the IBM PC, considering it is just plain old standard Adventure that was ported down a long time ago.

**PC:** Do you have any figures on how many IBM PC owners use your operating system?

**Trower:** I don't have an exact number. Portia Isaacson did research just last December, I think, and her investigation showed that for IBM PCs, more than 95 percent were using MS-DOS, 2 or 3 percent were using CP/M-86, and the remaining percent were using the p-System.

**PC:** Your BASIC, at least the cassette version, goes out with every single IBM computer, but are there any figures on how many PC owners actually use it?

**Trower:** It's hard to say. That BASIC is probably used more than anything else. Most people use it simply to get acquainted with the language. I have not seen an IBM yet that did not have a disk drive built in. It's relatively uncommon to find anyone using one of the smaller BASICs.

**PC:** Do you have a feel for how many people who buy IBM PCs use BASIC as opposed to those who just take the BASIC manual out of the carton and put it right in the closet?

**Trower:** Not really. The majority of people who buy microcomputer systems generally do so for a specific application. They buy MultiPlan or a word processing package or accounting package.

I think they probably spend their spare time with BASIC to get acquainted with programming because BASIC lends itself to casual use. I suspect that BASIC is used heavily in educational institutions. BASIC is probably the most frequently used piece of educational computer software around, if you compare it in relative terms to anything else on the market.

**PC:** Of all the BASICs out there for micros, does Microsoft have the lion's share?

**Trower:** In terms of BASIC in general, Microsoft is clearly dominant. In terms of the BASIC interpreter market, we believe that we probably own greater than a 95

**SEATTLE**  
*is about as far away as  
you can get from Boca  
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percent market share. In terms of the compiler market, we share that with some of our competitors, most notably Digital Research. DRI has two versions of BASIC on the market: their C-BASIC, pseudo-code compiler, and their full native code compiler.

On the PC specifically, I don't have any figures on how they specifically compare. My guess is that we probably dominate the industry for the PC as well. There are very few brands of personal computers on the market that have a name for themselves that don't have Microsoft BASIC running on them.

**PC:** How did Microsoft grab such a huge share of the market?

**Trower:** Microsoft came into the micro industry as it was just starting. Everyone's

probably heard the traditional story of how Bill Gates and Paul Allen created a version of BASIC on an 8080 emulator and took it down with them to the folks at MITS and got it up and running right away. So it was really one of the first pieces of software available for a micro-computer.

The other significant event was lining up the customers who came on soon afterward—especially the early sales work that Bill and Paul did with Apple. After all, before he bought MS-BASIC, Steve Wozniak already had integer BASIC running on his Apple. But, Bill and Paul were able to persuade him that he needed a version of Microsoft floating point BASIC on that machine.

**PC:** How did IBM become involved with Microsoft?

**Trower:** I don't know exactly what went on, since I wasn't here at the time. What I was told was that IBM originally just came to Microsoft, and said, "Sign these non-disclosure forms; we just want to talk to you." Then they sat down with Bill and Paul and discussed what products Microsoft had. The way that meeting was summed up was, "We'll get back to you if there is anything we need to talk about. Don't consider this as anything significant. It doesn't mean that we'll do any business with you. It's just that we wanted to come up and talk to you." A short time after they had gone, there was another contact from IBM saying that they wanted to acquire BASIC.

There's also the story that they wanted



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an operating system to go along with the BASIC. As I understood the story, we referred them down to the folks at DRI. There are lots of rumors and I don't know what the true story is but that didn't work out. So IBM came back up here and said, "Give us an operating system." Fortunately, we were able to provide them with an operating system.

We had been working closely with Seattle Computer Products at that time. They had an operating system running on their system and we had an interest in keeping in touch with them. We are both

Actually, Microsoft back at that stage probably consisted of fewer than 15 employees. We have almost 400 now.

When IBM came up and said they wanted our BASIC, Bill and Paul worked with them on a specification for the language. Originally, IBM anticipated that they wanted to sell this at a low cost, which meant no disk drives, and so they wanted a cassette BASIC. It turns out there are probably very few people who actually use an IBM with a cassette. It was probably a good gamble to go ahead and do it at the time. And the version of BASIC they wanted to do was to be drawn out of the history of some of the things we had done in BASIC.

Back then, we had a standardized version of BASIC running under CP/M-80 that we distributed through retail channels. BASIC originally came out of the 8K product that we sold to Apple, Commodore, and Radio Shack. We added program development features that became extended BASIC. And then disk drives became a standard part of system, so we

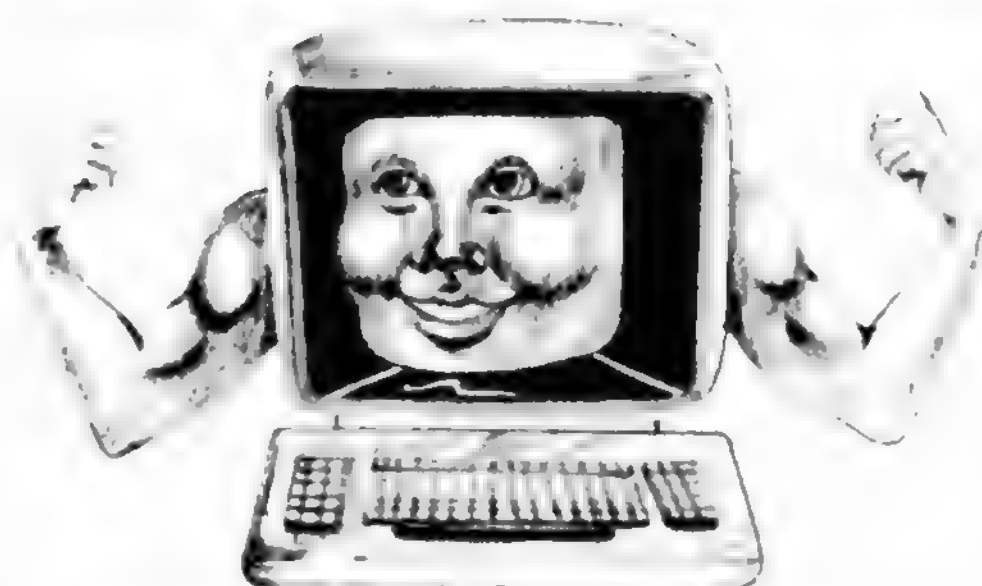
had disk extended BASIC. This then evolved into the BASIC interpreter when CP/M-80 came out.

**B**ASIC  
originally came out of  
the 8K product that we  
sold to Apple,  
Commodore, and Radio  
Shack.

But all along, we had done special versions of BASIC for many of our Japanese customers, as well as some in the U.S. We were very much in the custom industry at that time, and there were lots of customers who had graphics or sound and wanted extensions for those features. Eventually, we had a base of such features, which

**T**HERE  
are lots of rumors.

small computer industries here—obviously, this is not Silicon Valley—who were keeping in contact with one another.



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were not part of our standard BASIC. But we integrated those commands—like the graphic features and the music, the full screen editor, and the light pen and joystick support—into IBM's version, put that all into a BASIC, and then divided it up into the three levels IBM wanted.

**PC:** Were there any things that didn't get in to the BASIC?

**O**NE OF THE things that we're doing right now with all of our languages is moving them all into C.

**Trower:** Not as far as I know.

**PC:** Is IBM's version the most advanced that you put out?

**Trower:** What IBM has is what we call

GW-BASIC, which is a special version of our BASIC interpreter.

**PC:** What does GW stand for?

**Trower:** There are three things that people think it stands for. One is that it stands for Gee Whiz; one is that it stands for Gates, William; one is that it stands for George Washington. We had written G BASICs in the past, and this was a way to differentiate that G BASIC from the other G BASICs we had done. The idea behind GW-BASIC was to build a standardized product. IBM's was the first version of GW-BASIC.

**PC:** What are all the BASICs written in?

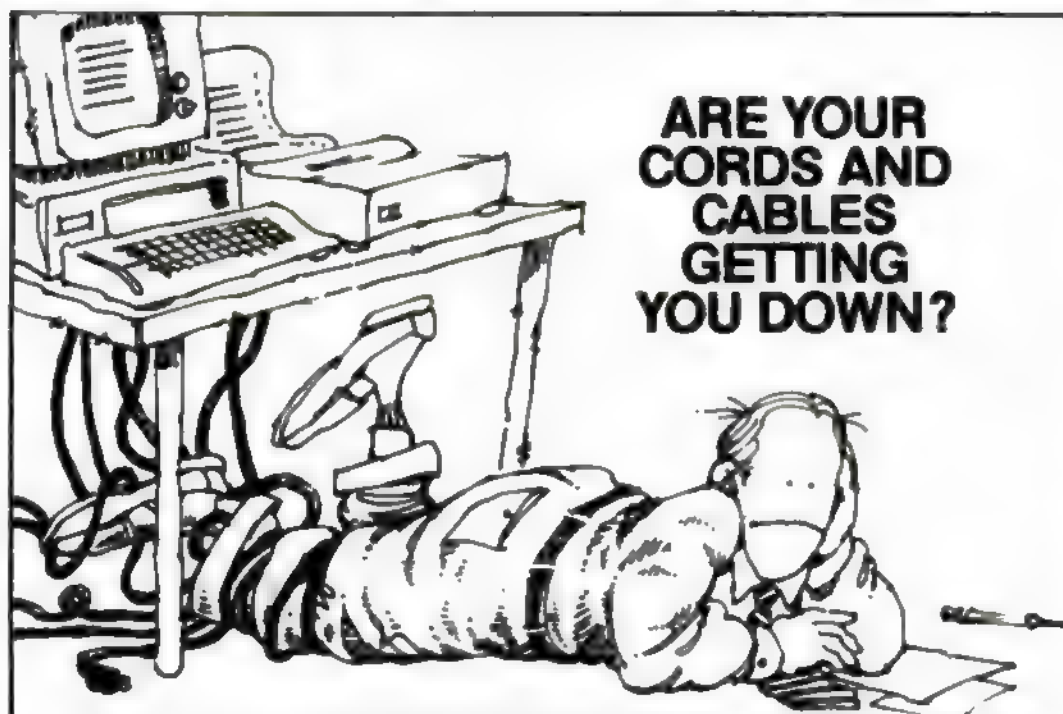
**Trower:** All the BASICs created up to the present are written in assembly code. But one of the things that we're doing right now with all of our languages is moving them into C. It makes them much more portable. Moving from the 8080 to the 8086 is reasonably easy, but moving from 8086 code or 8088 code over to the 68000 is a little more difficult.

The version that IBM shipped was GW-BASIC 1.0, and what we did after we dis-

tributed that through IBM was to go even further in our development cycle. We wanted to be able to take the same BASIC that we had written for IBM and provide it

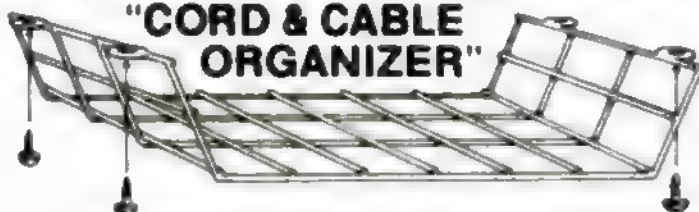
**T**HE problem with GW-BASIC is that while it has lots of nice features, they're all hardware-dependent.

for other systems in such a way that OEM customers wouldn't be dependent on us for customization. It didn't seem reasonable for us to spend 5 or 6 months developing each new version. We felt that we had a very nice BASIC that a lot of customers were very interested in. But it



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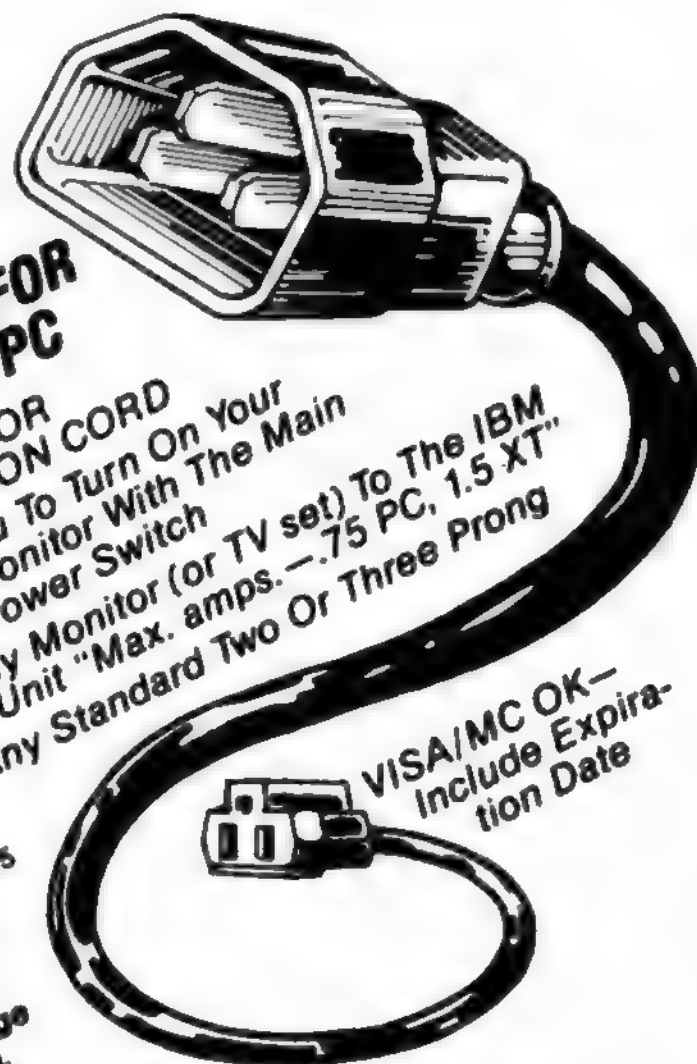
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would be ridiculous if every customer had to wait in line to get his version.

The problem with GW-BASIC is that while it has lots of nice features they're all hardware-dependent. And unless every systems manufacturer designed his hardware after the IBM PC, we couldn't automatically just put GW-BASIC on that system. So we formed what we called the GW Kit. Essentially, we took all the high-level code, the real guts of BASIC, and separated it from the rudimentary features that are hardware specific.

We have a set of specifications and a questionnaire that we provide to all OEM customers. They produce low-level code that their engineers can write for their system a lot more quickly than it would take for our engineers to have to learn about their system and then do the writing. Then they can link their routines together with the high-level code of GW-BASIC and have GW-BASIC up and running very quickly.

Standard GW-BASIC is not the most advanced version we publish. IBM now offers 2.0 GW-BASIC, which it calls advanced BASIC 2.0. This is a superset of GW-BASIC 1.0 with the additional features to support DOS 2.0, and the extra graphics. There are at least 2½ to 3 dozen customers for GW-BASIC right now. GW-BASIC is an interesting product, because while it has a standardized set of features designed originally for the IBM PC, it's also variable, so that customers did not have to be in any way locked in by the feature set of the IBM. If a customer has greater graphic resolution than the IBM, he can support a

So, it's possible for a customer to be very closely compatible with the IBM BASIC—as Compaq is—or very different. Very few systems are really different, because IBM's BASIC has become the standard for the 8086 MS-DOS world. Even so, we do still offer, through our retail channels, the standard form of the BASIC interpreter without the graphics and anything that is machine-dependent.

We've contacted most of our customers about moving their GW-BASIC to 2.0, if they like. IBM's compiler is not our standard compiler. If you compile a BASIC program on the IBM, it won't run on the Texas Instruments (TI). If you took our standard compiler, which doesn't have those extra extensions, you could compile a program on one machine and run it on another machine, provided that the second machine reads a standard 5¼-inch MS-DOS format.

**PC:** Apart from the hardware-specific features, are there really any noteworthy dif-

ferences between IBM's BASIC and most other GW-BASICs?

**Trower:** Customers come to us and say they want to make their GW-BASIC closely compatible with IBM's. On a feature-by-feature basis, they can be very compatible, right up there. The problem—and this was mentioned in an article somewhere—is that in some sense the IBM is not even compatible with itself. Some software runs with a color graphics card, and some software doesn't. Flight Simulator is a good example.

But, there are areas where people run into problems when they're trying to see if their version of GW-BASIC will run every application out there. When you look for compatibility, you're looking at the hardware, and sometimes even timing can make a difference. We found that Flight Simulator would experience a problem on one IBM look-alike simply because the timing was a little different.

We can suggest ways that OEMs can make their BASIC more compatible to IBM's. But there's another problem that

**THE**  
*problem is that in some  
sense the IBM is not  
even compatible with  
itself.*

greater graphic resolution; if he can support more colors than the IBM, or a greater number of printer ports, he can do that.

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fosters incompatibility. A lot of the early software developers found little tricks and routines—I think some were actually published in the IBM documentation—and they PEEKed and POKEd to those routines. If the hardware is not 100 percent like IBM's, such tricks may not work.

Also, when you move strings out to a file in IBM BASIC, the buffers for your files are static, just as they had been with Microsoft BASIC. This comes out of the history of Microsoft BASIC where file buffers are always static. With GW-BASIC, we made a modification so that these buffers would be dynamic, which doesn't present a problem if you write a clean application. However, one software developer had a problem with one of his packages. After he would field his strings out to the file, he knew that on the IBM they were being kept in a static buffer, and so he'd go back in with his pointer and PEEK, then pull those strings back out.

Well, good programming practice says you don't do that, and you don't go looking around inside BASIC for hard addresses or routines to take advantage of. Any software that does that on one version of GW-BASIC will be less likely to run under another version of BASIC, because those things can't be identical.

**PC:** Some of those PEEKs and POKEs are inserted to speed up programs.

**Trower:** That's why we offer compilers. An interpreter, by its very nature is going to be slow, and the IBM, while it's an excellent machine, is not running the fastest processor it could. There are machines on the market today that will probably run our version of BASIC faster than it would run on the IBM, because those other systems were built at a later date and have faster processors in them.

But speed really hasn't been much of a problem. We've always had the hallmark of being able to provide a closely compatible compiler with our interpreter. In fact, they're probably greater than 97 or 98 percent compatible. The leftover percentage makes a lot of sense if you understand where the incompatibilities are.

We provide the interactive environment of the BASIC interpreter, so that you can go in and write your programs and get them all running nicely, and do things like jump out of the program and add lines. The interpreter provides many program development features. Then when you finish, you can run the program



through the compiler for the speed advantage; generally a compiled version runs three to ten times faster than its interpretive counterpart.

**PC:** Your floating point standard is differ-

**GOOD**  
programming practice  
says you don't go  
looking around inside  
BASIC for hard  
addresses or routines to  
take advantage of.

ent from Intel's. Intel uses the IEEE standard. Isn't this a real potential problem?  
**Trower:** Well, most people who use Intel's numeric processing chip are more interested in languages like Pascal and FORTRAN where we have put 8087 support into the languages. The numbers I have don't indicate that there are that many PCs out there with 8087s.

**PC:** That's probably because IBM announced its availability only recently. Six months ago there were only two or three companies that supported the chip and sold the necessary software. Now there are about half a dozen; so it is growing.

**Trower:** I'm not denying that there isn't a market for the 8087; I'm saying that most people don't need it. When we first developed BASIC for IBM there was no assurance as to when and in what quantities that chip would be available. Up to the present, we've gotten more demand for a decimal-based math pack in our BASIC than requests to move to the IEEE standard.

If we shifted to that standard, it would make some existing software out there somewhat incompatible, because the numeric format and the way data is stored would be handled differently. You would face a trade-off in terms of compatibility with what's already out there.

**PC:** What about GW-BASIC are you proud of?

**Trower:** The graphic routines, the music, and the extra GW advantages have provided significant features for that BASIC.

We've continued to enrich the language as much as we can, with the added GW features. These are probably what most OEMs who come to us for BASIC now want. They don't come for the standard BASIC; they want the GW-BASIC, partly because they want to have at least as much as the IBM does, but also because

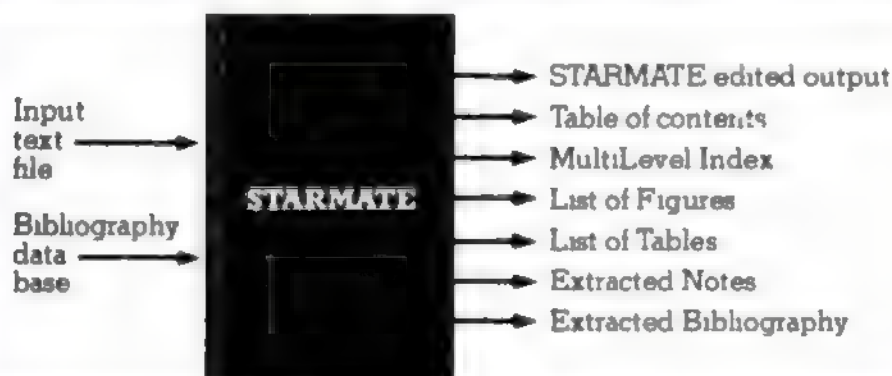
the extra features that we added allow BASIC users to tap into the hardware capabilities of the system.

Graphics capability is probably the most notable feature of that BASIC, because it's so popular these days. And the ability to draw lines and circles and different shapes on the screen—which

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gives you some idea of the internal potential of the machine—is very attractive to the OEM because it means that even a child or a beginning programmer can sit

## BY NO MEANS is BASIC a static product here.

down and tap into the power that he has in the system.

With the sound abilities of GW-BASIC, for example, you don't have to design any complicated assembly language routines to try to generate music out of the hardware, even though all you have is a tiny speaker. Light pens and joysticks are probably not used for many serious applications, but they mean that there's a level of interfacing to the computer that doesn't force you to go strictly through the key-

board.

People want to get at most of the horsepower that's sitting in their computers. And generally the only people who have been able to do that in the past were the software wizards, who magically tickled the bytes and were able to produce fantastic pieces of software. The fact that we've built these extensions into BASIC allows even someone on a very simple level to go in and experiment with those features.

That's not the only avenue that we've taken with BASIC. Because there's been demand from the business community for certain extra features that would help them write business applications, we have released a Business BASIC compiler, a special version of our conventional compiler. It has a decimal-based math pack that can improve your precision if you deal with monetary amounts.

In the past, Microsoft's math pack had been binary-based, which is great for all the different applications BASIC is used for. People use it for educational purposes, engineering, scientific program-

ming, business programming, and just to get familiar with computers. The binary based math pack is quite sufficient; it actually adapts itself to these different environments. But when you're dealing with monetary amounts, it helps if you can target your math pack for that.

That's a specialty market, so rather than add those special business features to our BASIC, we have created a separate Business BASIC compiler. It is different

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from GW-BASIC, but comes out of the same root of the tree. We've added extra features like multi-line functions, so it's

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really designed for a more advanced programmer who needs to write serious business applications in the BASIC. It's available for MS-DOS, and is not machine specific, so it will run on the PC.

By no means is BASIC a static product here. GW-BASIC is not the end of Microsoft's BASIC. We get lots of inquiries, and we make an honest effort to keep our ear to the users out there—not just our OEM customers but the people who are actually using it—to find out what kind of applications and features they want.

**PC:** What do they ask for?

**Trower:** There are a lot of people asking for things like ISAM support, and form support. There are a lot of inquiries asking if there will be any way to have BASIC files and Multiplan files talk together. Many people are still looking for further enhancement to the graphics package because that's very attractive.

The version of GW-BASIC that we have right now could never fit in an 8-bit system; it could only fit on 16-bit system, so when the technology jumped from 8 to 16

it was a terrific relief; it allowed us to put all these extra features into BASIC. But even so, everyone would like to add new features.

A lot of users would like to take all the versatile BASIC features and make them totally portable, so they would not be limited to one machine. Users are realizing that there's a greater world out there than just the IBM-PC; that IBM has motivated a whole realm of 16-bit systems.

People would like to see more program development features built into the BASIC, utilities for searching and finding text, and the capacity to replace text. There have been suggestions for some sort of built in cross-referencer. A number of things that are in BASIC now could always be appended as utilities. Now that we have an environment, we put just the choicest things in the BASIC.

**PC:** Generally, do upgrades coincide with upgrades in DOS?

**Trower:** Yes, that's a good point. With BASIC as well as with all our languages, we're limited in terms of what we can do

by the environment we're in, which is, frankly, why I'm glad that most of our 16-bit work is done in operating systems that we're very familiar with, such as MS-DOS and Xenix. Bill Gates has mentioned several times that his interest and the interest of the company as a whole are to be able to provide enough support in the operating systems so that people don't have to go around the operating system to try to write their code, which always leads to incompatibility from machine to machine.

Right now, one of the biggest drawbacks is providing a generic form of BASIC that allows you to do screen positioning. That's a hardware-specific function. If we can integrate things like screen positioning into the operating system, and perhaps take the graphics out—there is no reason why graphics support has to be in the language—we would make a lot of people happy.

**PC:** So you're saying that you'll eventually have all those graphics features in the operating system?

**Trower:** Right. To have some sort of sup-

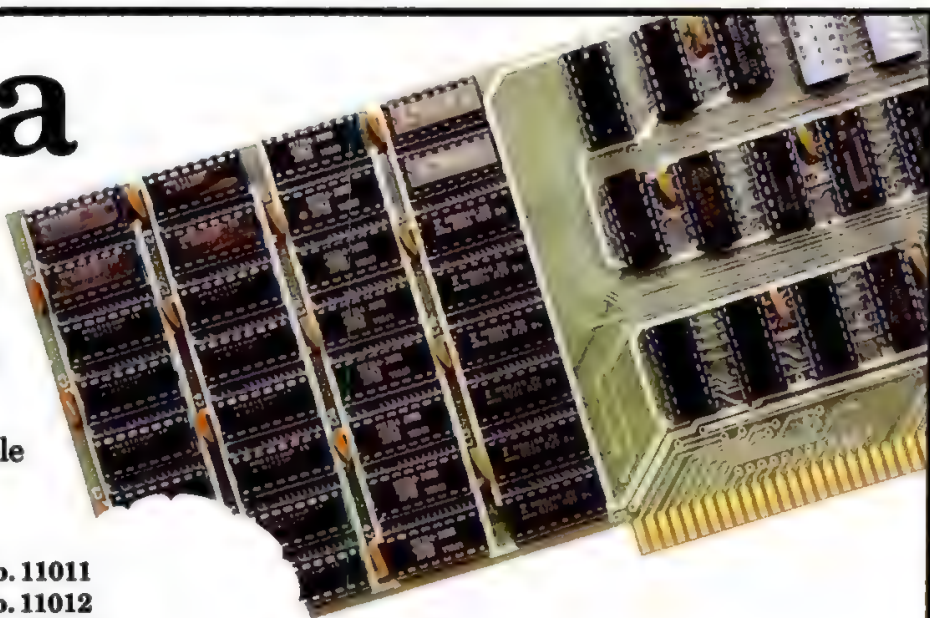
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port for people who want to do screen positioning, so they don't have to make calls to the hardware and write routines to do it. Instead, they should be able to call directly to the operating system and have the operating system provide that environment.

**PC:** Is this a general trend you see happening?

**Trower:** Yes. There is definitely a commitment on Microsoft's part to increase the functionality of the operating system to make software more portable.

**PC:** Apart from GW-BASIC and the two compilers, are there any other BASICs that will work on the PC?

**Trower:** We sell our products directly to IBM, which basically sells them as if they were their own products. In addition, we have our retail outlet. In March of this year we started rolling out our MS-DOS language products.

We've put all of our standard languages under MS-DOS as well. So we have our standard BASIC interpreter, the core of what GW-BASIC is built on—if you

stripped away the graphics and the screen positioning you come down to standard MS-DOS BASIC—and we have a standard BASIC compiler also for MS-DOS, and we

## THERE is no reason why graphics support has to be in the language.

have the Business BASIC compiler. All these products are designed for MS-DOS systems, so they'll run on the IBM, the Wang, the Compaq, the TI, and others.

**PC:** Have you heard any complaints about this?

**Trower:** One of the things that has been most surprising to us is that people—especially in the 8086 family of processor-based computers—still feel restricted,

since the programs are limited to 64K of code, and 64K of data. In the 8-bit area, if you have the BASIC interpreter and the operating system in there, you have whatever is left to do your program. Now in the 16-bit area, with some of BASIC's house-keeping in memory, you get about 60K or 61K of program space, which is more than twice what anyone ever had before.

**PC:** But if you're up to the 60K area in programming, shouldn't you be writing programs in other languages?

**Trower:** That's what we had thought. But many people really expect to be able to program in a large space, even in BASIC, though they have more than twice as much as they had previously.

We're looking for alternatives in the 8086 world to see what we can do in that area because people do complain about their program space or their data space. Some of these people who are writing serious applications have tremendous amounts of data to store, large arrays for instance, and even though users have a larger environment than they have ever

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had before, they still say that if they have a 512K machine they'll want to use all of it for BASIC.

It's a little unreal to me, but I can understand why they would like to use more than they have. People didn't say "Aha! We had more space than we had before." They said "How come you don't let me use my full machine?" That's one area where we are looking at how we best can provide alternatives.

For example, you can get around the space limitation in Business BASIC by linking separate code program modules together. No single one of them can be larger than 64K but you can link several of them together. You are still limited to 64K of data but by linking modules together, you can use more memory than you normally could with the normal compiler. There are ways of providing larger address spaces, but it's a little complex in the environment that we're in.

**PC:** Earlier you mentioned 68000s. Is that because some of the code you now write is for 68000-based machines, or is it because

you think that chip is going to assume a dominant role in the future?

**Trower:** It's obvious right now that the dominant chip out there is the 8086 family. It's hard for me to say whether this will continue to be the case. Obviously, there is a variety of chips in that family that will

---

**E**VEN  
in BASIC, people  
expected a larger  
program space, even  
though they had more  
than twice as much as  
they had previously.

---

handle some of the limitations of the current one.

**PC:** How do you keep in touch with end users to hear how they feel?

**Trower:** Well, on the PC specifically, people have questions and call us because they know we originated BASIC. We find they are somewhat frustrated by the fact that we generally cannot provide any information or any support directly to them. It is difficult to explain to them that this is IBM's product and that our contract with IBM says that they will provide support for the product. That's as it should be; if we started providing fixes, or workarounds, IBM would have a tremendous time trying to support that product.

**PC:** You just started a book division. Does this mean you are going to do things like tutorials, or is it just sort of an end run to help users who have these kinds of questions?

**Trower:** The publishing group is a new enterprise here. We get complaints sometimes, that people don't feel—as in the case of BASIC—that the manuals are really tutorial enough. Well, they were never meant to be tutorial; they were reference

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the language.

Robots are another potential area for

There are people now programming on minicomputer BASICs and COBOLs, who are interested in moving their applications down into the micro environment. They really couldn't realistically look at that before because 8-bit micros just didn't provide a large enough environ-

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ment. But now you have 16-bit micros that have larger programming space, and hard disk drives for large storage capacity.

**PC:** What about souping up BASIC with really advanced features?

**Trower:** In some respects we have some rather advanced features right now in GW-BASIC: the event-trapping features, for example. What you are actually doing is setting a programmable interrupt that sits there watching and waiting for something to happen while your BASIC program is processing all this other stuff. When you find that situation happening you can go off and target the control of your program somewhere else.

**PC:** You just came out with Lattice C—what's your connection with Lattice?

**Trower:** We basically felt that C was a very important language to have. Although we have a version of C running with our Xenix operating system, we didn't have anything for the MS-DOS operating system. To be honest with you, even as fast as this company is growing, there are only a certain number of things that we can do and it's a matter of picking and choosing what opportunities exist. It seemed reasonable to us that if there was a good product out there on the market satisfying a need in an important part of our product niche, we would work out a licensing arrangement to distribute it rather than spend the time to go ahead and develop it.

**PC:** What are some of the others that were picked up?

**Trower:** Our new version of Lisp. It's specifically targeted right now for the IBM PC. We say it runs on the PC. It also runs under CP/M-80. We are moving through a transition right now where it will become an MS-DOS version. There will be some enhancements. The only real difference is that documentation will help you understand what the difference is between how some features might work on the PC and how they might be different on the MS-DOS system. Lisp was acquired from an outside software source. As with Lattice, we felt that it was a good product.

**PC:** When you do something like this do you fine-tune it or do you release it without making any essential changes?

**Trower:** Well, in the case of both Lisp and C, the only thing that we do is repackage. There is some difference between the C that Lattice sells through Lifeboat and the one we'll sell, but nothing that we really



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monkeyed with. The difference is that we have version 1.04; Lattice has 1.03 out right now. They gave us a version that was a little more advanced—there is an object

---

**W<sub>E</sub>**  
*believe in COBOL, too.*

---

module disassembler in our version that isn't in the other one. They'll eventually put out that enhanced version through Lifeboat as well.

We also put our library manager and our linker in it for all of our 16-bit languages. We included the linker though most people get that with MS-DOS anyway; we wanted to make sure people had it.

**PC:** Lattice offers a large library of subroutines. Do you also offer that?

**Trower:** No.

**PC:** Will theirs work with yours?

**Trower:** It should work just fine.

**PC:** Are you also planning to put out libraries that will help programmers?

**Trower:** No, not at the present time; we are just providing the compiler. We are looking in all the language areas for good utilities. In the case of the Lattice product we felt that they have some utilities that are great. Our major concern was to provide the language itself, and if there's a significant utility—I'm not saying their library of subroutines isn't significant—that we will greatly enhance the sale of our product or help program development people, we will either point people to that product, or work out a licensing arrangement if it's significant enough.

**PC:** Is your Pascal compiler a version of IBM's or your own?

**Trower:** Well, essentially IBM's Pascal is our Pascal, as well. They come from the same source, and the version of Pascal we distribute through our retail channels is a slightly more recent release than IBM's.

**PC:** Can you give us a list of the languages that you do sell?

**Trower:** For MS-DOS-based machines, we have the BASIC interpreter and the BASIC compiler, Business BASIC compiler, our COBOL compiler, Pascal, FORTRAN, C, and Lisp.

**PC:** What about LOGO?



**Trower:** No, LOGO is a very interesting language. It's primarily being used right now in educational communities.

**PC:** Is it a fast-growing market?

**Trower:** Definitely. I can't say that our eyes are closed to LOGO. Generally, our strategy in the past has been to provide languages for programmers. I'm not saying that LOGO isn't a language for programmers, but at present, it's more of a computer literacy language. In some ways, we're watching it very carefully because that's how BASIC got started.

**PC:** Are there any other languages out there that are going to be important for the micro market?

**Trower:** There are other languages out there. I've heard of versions of RPG for micros and versions of DIBOL. There are adherents who love FORTH.

**PC:** Do you think that between C and BASIC and the others Microsoft produces, you have the market covered?

**Trower:** I think we provide probably the best in terms of the widest possible range of languages right now.

**PC:** Do you see one language taking over in the future?

**Trower:** I see C becoming very significant. I don't know that it will take over. People adapt to certain languages and become comfortable with the features those languages provide. From the programmer's viewpoint, C is great, because for most people who program in assembly language it's a very natural progression to move into C.

Someone coming out of a more traditional language environment would probably find C a little harder to get used to because he wouldn't have all the built-in functions that he used in his other language. I see C becoming very significant in program development. We have a lot of ongoing internal projects where we move a lot of our software into C.

At Microsoft, we're also involved with programming on a different level. If you think about it, the Multitool products really are almost a programming environment for end users. When you put together a spreadsheet, in a sense you're programming that piece of software. It's not programming in the traditional sense of FORTRAN or Pascal, but there are formulas that you're putting in; you're establishing relationships; and you're setting up certain variables.

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ming as well as the traditional kind. There's a lot of effort right now going into our Multitool family of products, that will let users do such things without having to know anything about programming.

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*probably more  
appropriate to talk  
about COBOL in a  
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ever before.*

PC: Will there be a shell that ties all the Multitool components together?

Trower: We do offer a product, sort of a shell for MS-DOS, although it's certainly not something that ties everything together. But it's the first step. It allows you to look at your directory and point at different things. It bridges the gap between the Multitool products, by taking the interface we've been very successful with and giving users a means of using MS-DOS in that area.

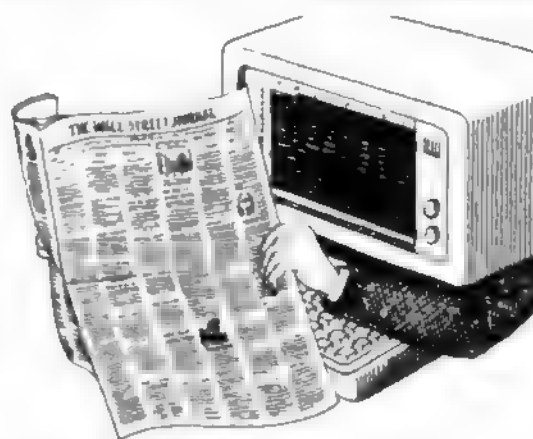
PC: What you seem to be saying is that in the future, hard core programmers will use C, and beginners will use some type of programming-like tools that don't require coding. BASIC is caught in the middle. Will it always be around?

Trower: If you're talking about 20 years from now it's a little hard to say. I think there's still a long life ahead for BASIC. I don't see anything in the short term that would preclude BASIC from not continuing out there.

BASIC is a language that people are exposed to more than any other software that's around. When they buy a personal computer they may not always indulge themselves in working with it. But people like BASIC. It's the only thing that really provides them an opportunity right now to get familiar with their system so that they can actually control it.

If this is somehow replaced with an environment that allows people that much access without having to go into a traditional language, it's possible that people might not use BASIC anymore. I think that's still a long way off. /PC

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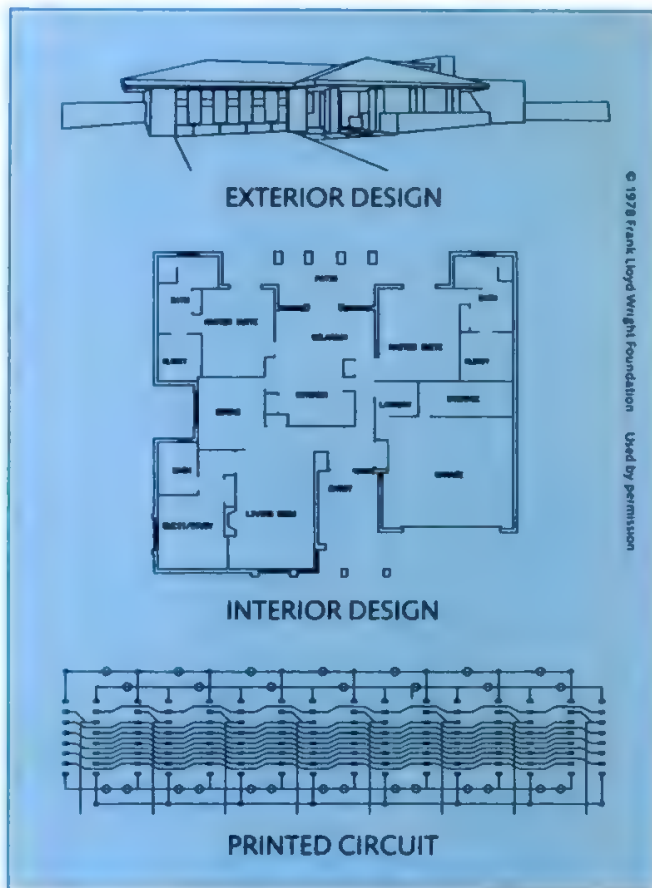
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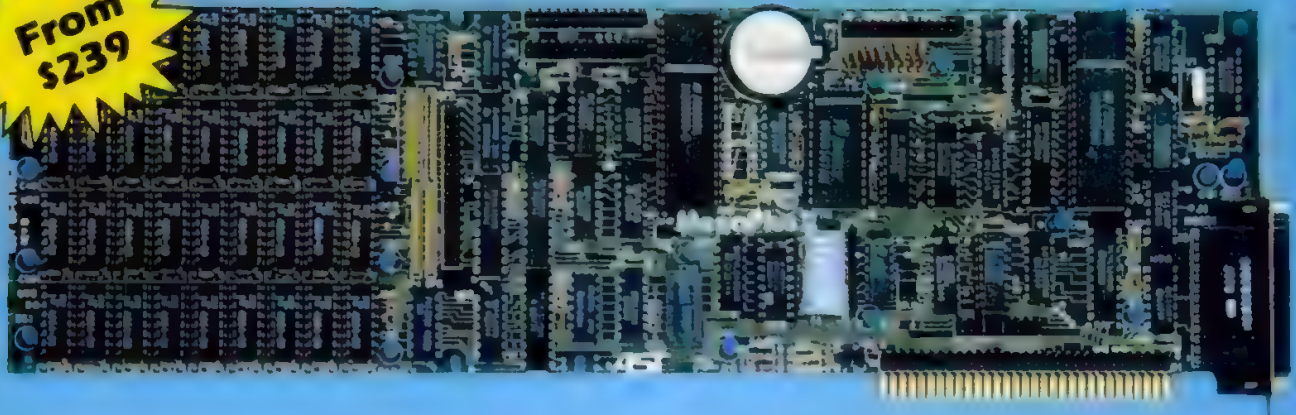
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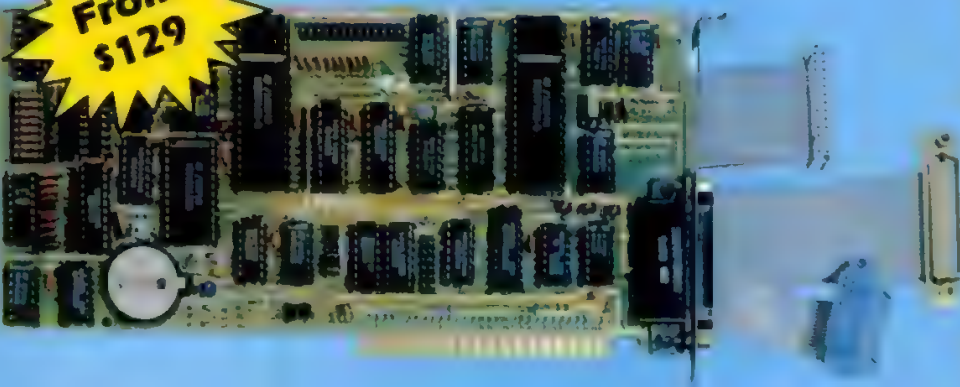
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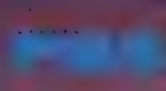
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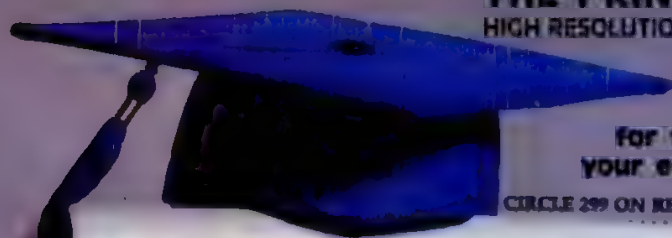


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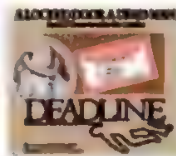
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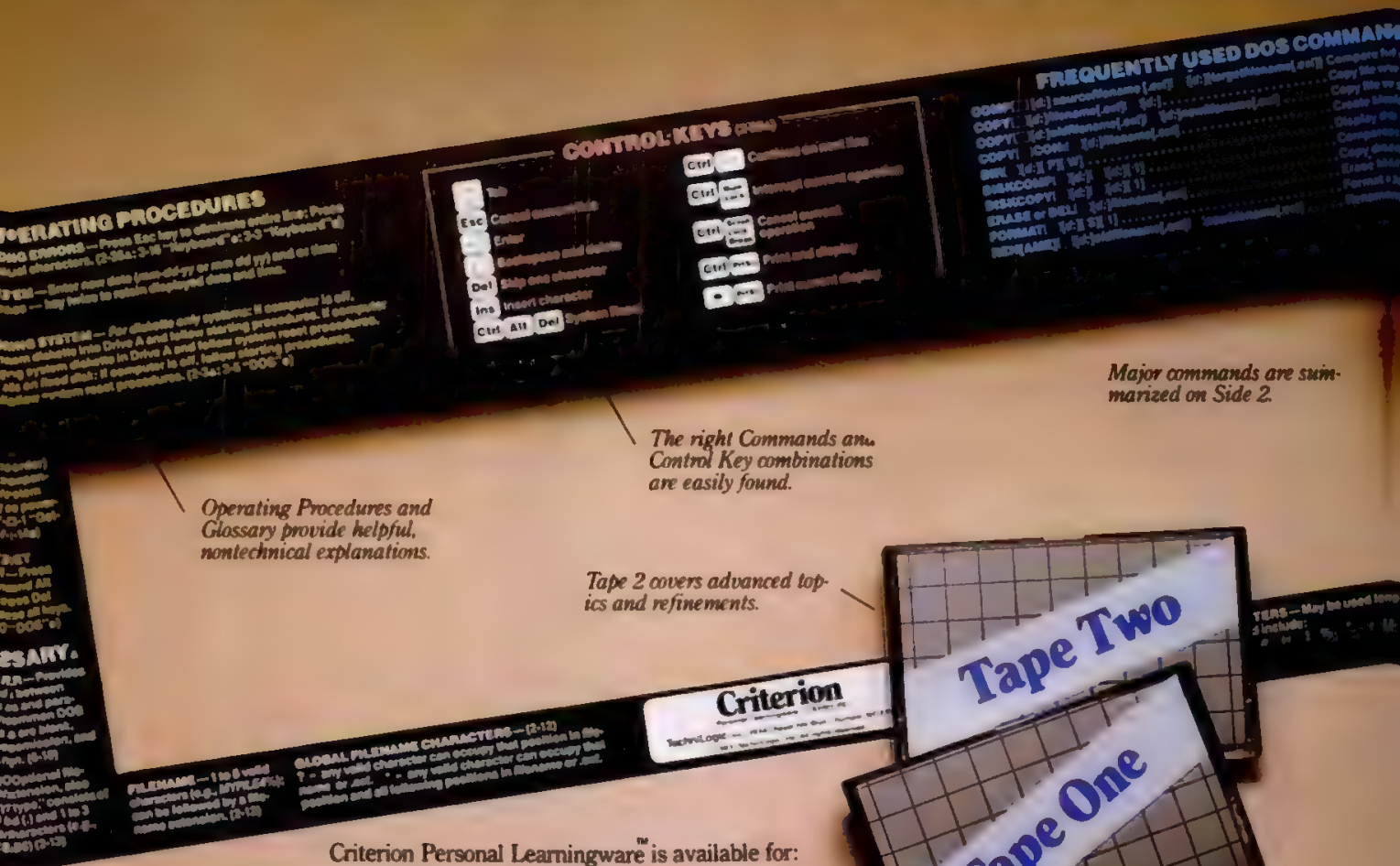
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User-Designed Input Screens	✓	PN*	✓	✓	✓
User-Designed Lists, Form Letters Labels, Pre-Printed Forms	✓	PN*	no	no	no
Random Record Access by Key	✓	PN*	✓	no	✓
Sort Data	✓	✓	Output Only	✓	✓
Calculated Fields & Totals	no	✓	Output Only	✓	✓
Records per file	1200 (64K)‡ 2200 (128K)	65535‡	1100 (SS Disk)‡ 2200 (DS Disk)	32767‡	32767‡
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One part is the "hardware," the machinery itself. The other is the "software," which tells a computer what to do, the way a driver tells a car what to do.

Without software, a computer can't do anything. And vice versa. You have to buy both.

## **Buy the software first.**

Since the reason you're buying a computer is to get the capability the software gives you (remember it's the software that tells the computer what to do), it makes good sense to pick the software first.

Start by making a list of the things you want the computer to do. Possibilities include word processing, inventory control, accounting, graphics, recordkeeping—you name it, there's probably software that does it.

Next take your list into a computer store and ask the salesperson to demonstrate software that will do the things you want.

Even though you'll need a computer for the demonstration, keep in mind the computer is just a vehicle. The software is the driver. Once you've decided on software, picking the rest of the computer system will be that much easier.

## **The simpler the better.**

Some people will tell you that software has to be complicated to be powerful. Nothing could be further from the truth.

Good personal software should be, as the computer people say, "friendly." Meaning that it helps you do what you want to do without getting in the way.

Good software keeps the complications in the computer, where

they belong. And keeps the capability at your fingertips. It's that simple.

## **Simply see for yourself.**

You can read any number of interesting books and magazines about personal computers. You can ask your friends who have them.

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*Is BASIC a serious programming language? What are its main flaws? Will other languages supersede it? What changes does Microsoft have up its sleeve? Microsoft's Guru of BASIC, Mark Chamberlin, offers PC some surprising answers.*

# In Defense Of BASIC

Wait—don't turn this page, unless your computer came with a green eyeshade, and you're the kind of tunnel visionary who uses your PC exclusively to poke dollar amounts into spreadsheet cells. Not that there's anything wrong with financial planning. But ignoring the PC's astonishing programming ability is like visiting a nude beach just to admire the driftwood.

Say the word programmer to many people and they conjure up images of asocial computer nerds hunched over hulking consoles and cackling demonically as they transfer phony million-dollar accounts in a distant Bank of America mainframe, or tap into NORAD to send squadrons of fighters scrambling for nonexistent radar blips. These days, however, this couldn't be farther from the truth.

IBM doesn't give anything away for free, but it does provide a copy of Microsoft BASIC hardwired inside every PC it makes. (In fact, Microsoft has distributed well over a million copies of its BASIC in various incarnations and dialects.) You can run BASIC even if you don't own a single floppy; boot your PC with the drive door open and no disk in the slot and Cassette BASIC flickers onto your monitor.

But while IBM wanted BASIC in every machine, it didn't make the language easy to learn. The familiar olive-drab manual is an excellent reference book, but a terrible teacher. It is possible to learn BASIC by plodding page-by-page through the manual's alphabetical listing of functions, statements, and commands, but few people

ever do. IBM or Microsoft really should publish a separate BASIC tutorial, on manual or disk, or include a few instructive chapters in the conventional BASIC manual. Utter novices need to pick up a few fundamentals before they start, so they don't go apoplectic when they stare at a line like "A=A+1."

## Forced Thinking

There is a thriving market in third party BASIC tutorials and guidebooks, although none has the clarity and class of an IBM manual. BASIC is so simple that even the worst of these books can have a reader up and confronting his first syntax error in an hour or two. Many PCers learn from books like these, or from increasingly popular classes given at colleges and computer stores. Why are so many PC owners learning BASIC and waxing enthusiastic about the joys of programming?

Several reasons. Some like the idea of mastery over machinery. With a modest knowledge of BASIC you really can put the PC through its paces, make it do virtually whatever you want. Some like the puzzle aspect—figuring out how to turn an idea for a program into the code necessary to make the program work. Others enjoy the graphics it allows even non-artists to produce, or get a tingle out of tinkering with sounds and animations. Many like the way BASIC lets them whip together a program in minutes to handle complex mathematical calculations or other business needs.

Programming forces you to think. To get the computer to perform even the smallest operation you have to break the task into minutely simple steps, consider and protect against all the possibilities for error, and then find ways of expressing each of the steps logically or mathematically. Most people stop thinking mathematically the day they take their last math final exam in college, checkbook balancing notwithstanding. After so many years it is a genuine pleasure to use the math area of your brain again. It's like scratching a place you couldn't reach before.

If you spend enough time cranking out code, you even begin looking at everyday life differently, analyzing routine tasks automatically and breaking them down into their various logical steps, organizing things better. You can feel it happen. There is a sudden concern for efficiency. Programming makes you more perceptive, analytical, calculating. The ganglia bristle. You see something that's not exactly right and the gears upstairs begin whirring madly.

## Programming As A Strop

All computer languages have a limited vocabulary. It is a real challenge to define a complex series of instructions with the fewer than 200 functions, commands, and statements available in BASIC. And each of these program-building blocks has its own demanding syntax; put a comma where a semicolon should go and your entire program may go haywire—or crash

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to a halt. While this rigorous precision is often maddening, it's necessary and hones the mind. For those who feel their minds are plenty sharp already, there may be languages in the future with enough artificial intelligence to figure out what is needed and correct such errors. Or, future programming tools simply may not require this tough syntax to create workable code. But that's a long way off.

If you're not familiar with the above

terms, according to the IBM BASIC manual, "the distinction between a command and a function is largely a matter of tradition. Commands, because they operate on programs, are usually entered in direct mode. Statements generally direct program flow from within a program, and so are usually entered in indirect mode... Actually, most BASIC commands or statements can be entered in either direct or indirect mode... A function is used like a

## TRICK OR TWEAK

*The editors of PC Magazine announce the first "POKE Your Way to Fame and Fortune" competition.*

For years, PC users have been discovering new programming wrinkles not mentioned in any IBM or Microsoft BASIC documentation. Some of these are extremely useful, or even necessary. For instance, common patches allow users to check on the state of their NumLock, or force all keyboard character entries to be capitalized. Other, more sophisticated tweaks allow you to run a program like dBase II in color, or create entirely new palettes on the medium resolution graphics screen.

Microsoft and IBM both discourage using such "undocumented" features in your programs, and they do have a point if you're hammering together a piece of commercial software. The reasons they give make sense from their perspective: Microsoft wants to be able to export its BASIC to every MS-DOS machine on the market; and hardware-dependent PEEKs and POKEs that work on the IBM may cause havoc, or simply do nothing, in other systems. IBM wants to be able to change its ROMs—and introduce slightly different models—with impunity. And what IBM wants, IBM gets.

The World According to Microsoft dictates that instead of PEEKing and POKEing, you should write polished, highly commented and structured code, then run it through its compiler to speed up execution. No arguments here, except that Microsoft also frowns on including "undocumented" features, and that its compiler costs \$300. Also, compiled programs are not easy to tinker with.

But the most important point is that there are serious deficiencies in BASIC

and the PC hardware that you can correct by using such clever software patches. We certainly agree with Microsoft that designers of serious applications software should be wary of incorporating such tweaks if they want their programs to be portable. But for someone inventing a game for his child or a utility for himself, the more tricks he knows, the better able he is to get at all the horsepower of his system.

Have you figured out a way to bypass the cold-boot self-diagnosis? Or a trick to continue running, if you choose, after the PC spots a parity error? Or a clever scheme for getting more than the usual number of colors in graphics mode? Can you scroll your screen from side to side, or up and down a pixel at a time? Or play music using two voices rather than the one provided? Or run both color and monochrome simultaneously? Or unerase in WordStar? Or perform some other miracle so stupendous it makes all these other suggestions look feeble?

### Contest Details

Send us your best original, uncopied, copyrighted programming secrets, and the editors will pick the ten we feel are most ingenious or useful. Winners will each receive \$50, and their entries—along with their names, unless otherwise specified—will be printed in a forthcoming issue. Mail them by November 15, 1983 to:

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variable in an expression to call a pre-terminated operation . . ."

Commands can do things like run, save, load, and list programs, display files,

**M**OST PEOPLE  
stop thinking  
mathematically the day  
they take their last  
math final exam in  
college.

or jump from BASIC to DOS. Numeric functions can take one number and produce its cosine, or chop off its decimal portion, or use it to generate a random number. String and Input/Output (I/O) functions can convert variables from one form to another (decimal to hexadecimal, for instance), read characters from a keyboard entry or a file, or tell you something about a variable or a piece of hardware—what the third character of a word in from the left is, or whether a joystick button is pressed, or what color a particular dot on the screen is. Practically everything else in BASIC is a statement.

Each line of a typical program "listing," (the display of a program's contents) contains one or more instructions, written in the arcane "code" that the computer will understand. Languages like LOGO and BASIC come closest to being understandable. Others, like APL and FORTH are nearly inscrutable to the innocent bystander.

## The Joy of Coding

Writing good code is an art. Programs can be tersely elegant, or long-winded and clumsy. There are always several ways to get the same computer job done. Skilled code-writers can often accomplish in ten lines what brute force programmers do in fifty. There is much room in programming for cleverness.

Authors of conventional prose can never be sure whether their writing is good. They may be overjoyed with it one day, and hate it the next. One group of readers may take it to heart as gospel while another pegs it as inarticulate trash. Such

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uncertainty is not much of a problem when you're writing programs. While the first law of coding is that there's always a slightly shorter, better way to do it, a program either runs or it doesn't.

BASIC is an easy language to learn and use. It is a very "high" level language,

**E**XPERIENCED  
programmers  
universally seem to  
view BASIC with  
hauteur and disdain.

which means that it is closer than most languages to English. To run a program you simply type RUN. To print "hello" you tell the computer: PRINT "hello". There's even a "direct mode" that lets you

use parts of BASIC the way you would a calculator.

And the most popular version of BASIC is "interpretive"; users can slap a program together and run it right away. Most other languages (and even two other versions of Microsoft/IBM BASIC) are "compiled," which means that programmers have to perform additional, time-consuming steps after writing the program, before it will run. However, once a program is compiled the first time, it will subsequently run much faster than its interpretive counterparts.

Partly because BASIC is slow compared to the more esoteric compiled languages, and partly because it is the language of beginners and is often written very inelegantly, experienced programmers universally seem to view BASIC with hauteur and disdain. These days, "It's written in BASIC" is a statement that is whispered, not shouted from rooftops.

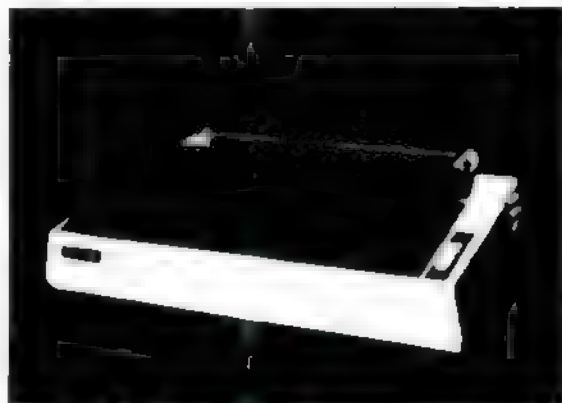
While it's true that if you have to write an operating system or a word processor or a commercial-quality animation, you

do so in C or Pascal or FORTH or assembler, BASIC is good for garden-variety programs, and just perfect for learning how to write code. You can grasp volumes about the language and about programming simply by loading BASIC into your PC, typing someone else's short program listing onto your screen, and then experimenting with it. If one line of such a program says: FOR A=1 TO 10, and you change it to read: FOR A=1 to 20, and then type in RUN, you can see the effect instantly. (In this case, the length of a loop—a reiterative series of instructions—is doubled.) IBM supplies many such short program listings in its manual.

### Do Not Enter

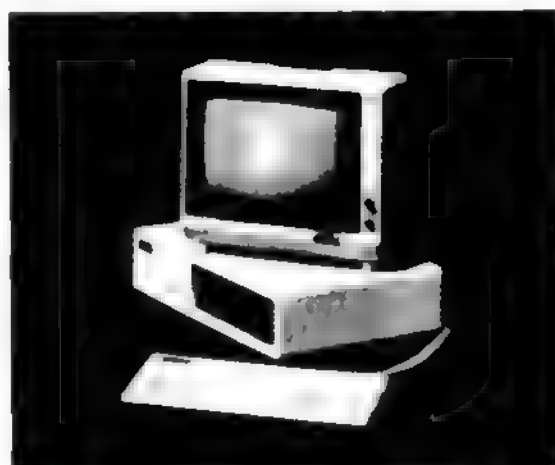
Interpretive languages can be very interactive. This is necessary for all but the slickest programmers, because the hardest part of writing programs is invariably "debugging" them. Once you've keyed in the initial program, you have to fine-tune your code to correct any errors, handle unusual and unanticipated inputs

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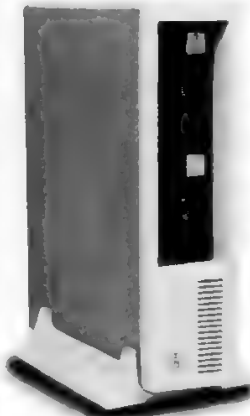


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(to take into account, for instance, headaches that arise when you ask a user to type in a number and he or she types in a letter, or a negative number, or a zero, or a number too big for the computer to handle, or a number with commas, or two numbers), and make sure it does everything you wanted.

BASIC is extremely interactive. You can run partially-written programs, or jump to the middle of a program and run one part you're trying to fix without having to wait for the program to cycle through from the beginning. You can throw in a statement to freeze the operation of a program at virtually any point, and have it print out the value of all important variables at that step in the program—in effect, take a snapshot of the program at any stage and have it tell you exactly what it is doing, and show you what is working properly and what is not.

Best of all, when you have to debug your BASIC code, you can alter a program quickly and easily, then try to run it to see if the change you just made fixed the problem. If one change doesn't work you can quickly try another. BASIC's onscreen editor, while far from perfect, does offer certain sterling features that make program creation and adaptation a snap. The PC's customizable program keys can turn editing and repair jobs from a chore to something automatic. The keyboard be-



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# FOUNDERS

*Bill Gates and Paul Allen are right out of central casting: brainy boy millionaires bristling with energy, ideas, volunteered opinions on everything.*

comes an extension of the fingers and the brain.

For instance, by defining PC function key #3 as: "Key 3, CHRS(2)" and PC function key #4 as: "Key 4, CHRS(6)" you can skip forward through a program word-by-word by tapping F4 and backward by

reduce footprint



Figure 1: Function key settings used to run graphics programs on the PC's graphic screen and then switch effortlessly back to the text screen for debugging. Note the use of initial CHR\$(27) characters to avoid syntax errors with BASIC's line-screen editor.

```

=====
100 KEY 1, CHR$(27)+"CLS:LIST"+CHR$(13)      ' 1 -- LIST (and ENTER)
110 KEY 2, CHR$(27)+"RUN"+CHR$(13)             ' 2 -- RUN (and ENTER)
120 KEY 3, CHR$(2)                             ' 3 -- PREVIOUS WORD
130 KEY 4, CHR$(6)                             ' 4 -- NEXT WORD
140 KEY 5, CHR$(5)                             ' 5 -- ERASE TO END OF LINE
150 KEY 6, CHR$(27)+"RENUM 100"+CHR$(13)       ' 6 -- RENUM (and ENTER)
160 KEY 7, CHR$(27)+"SCREEN 0:"               ' 7 1
170 KEY 8, "WIDTH 80:COLOR"                   ' 8 3 WIDTH/SCREEN/COLOR/CLS
180 KEY 9, "R 1,7,2:CLS"+CHR$(13)             ' 9 1
190 KEY 10, CHR$(27)+"CLS"+CHR$(13)           ' 10 -- CLS (and ENTER)
=====

```

pressing F3. Other keys—and combinations of keys—do everything from running and listing the entire program, to erasing from the current cursor position to the end of the line, to renumbering all the lines. And they can be customized for specific problems.

If you ever write graphics programs that use the IBM graphics screen, you'll probably want to switch back and forth between graphics (to see if the code works) and text (to fix it when it doesn't). As soon as you run such a program the PC turns on the medium resolution graphics

screen. This is fine for making circles but terrible for listing code, since this screen is 40 characters wide rather than the standard 80, and limited to a bizarre combinations of colors like white on purple. It could be a genuine nuisance to have to go through the laborious steps that will get back to your text screen, make it 80 characters wide again, set the colors that are most readable on your monitor, clear the screen, then list the program. But if you first set your function keys with the trivial program in Figure 1, you can do all this in about a half second by banging four func-

tion keys (7+8+9+1) in quick succession.

### Boy Millionaires

The IBM PC version of Microsoft BASIC is an enhanced version of Microsoft's generic GW-BASIC, which in turn is a descendent of the original BASIC-80 Microsoft designed in 1975. As with most customized dialects of the language, the enhancements are largely hardware-specific. All MS-BASICs share the most important commands, functions, and statements. But IBM's edition is souped up to take advantage of its relatively sophisticated graphics, sound, and other hardware abilities.

The early days of MS-BASIC, aka GW-BASIC, read like a pulpy Horatio Alger story. Founders Bill Gates and Paul Allen are right out of central casting: brainy boy millionaires bristling with energy, ideas, volunteered opinions on everything. And these days everyone listens; after all, these wizards have the Midas touch. Friends at a Seattle high school who cut their teeth

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on a DEC minicomputer, these two went from being proprietors of a homebrew data processing company called Traf-O-Data to micromoguls at the company that owns the operating systems and languages for just about all the small new computers on the market.

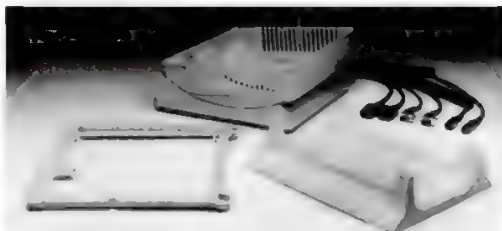
For the umpteenth telling of it, the tale goes something like this: Gates and Allen found themselves at a tender age in the employ of a Seattle computer firm with instructions to diddle the company's PDP-10. Hi-tech TRW was about to go belly up with a project in the boys' backyard to put all the power generated by the Columbia River basin network of dams and dynamos under computer control. The computer? You guessed it, a PDP-10. The two techie tykes stepped into the breach, performed their systems magic, and saved the day.

A few years later, an Albuquerque, NM outfit called MITS officially spawned the age of micros by screwing together a computer it named the Altair. Gates and Allen saw a writeup in *Popular Electronics* and decided the Intel 8080 chip at the heart of the hardware made this particular gadget a winner. They suggested to MITS pioneer Ed Roberts that they compose a BASIC package for the Altair. Roberts admitted others were on the track, but asked to see their submission.

Here's where the story works up the lump in the throat. Allen glommed the specs and spent several weeks creating an Altair simulator on his DEC mini, in effect turning the big machine into a silicon copy of the little one. After a month of frenetic hacking and tweaking, they called Roberts to make sure no one else had beaten them to the BASIC punch. Allen hopped a flight to New Mexico and on the plane ride down realized the pair hadn't designed a bootstrap loader for their program. So in a sweat he scribbled one down 30,000 feet up. Neither Gates nor Allen had ever touched a real live Altair before Allen nervously loaded their handiwork. It worked perfectly, the first time it was tried. Now you know why IBM loves these guys. They're superhuman. They cheated all of Murphy's Laws. You can almost see Rod Serling wandering into the frame as the spooky familiar theme music sifts up in the background.

ITS bought it and the rest is history. For you history buffs out there, everyone was happy until a company called Pertec purchased ITS. The progenitive pair lib-

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erated a copy of the language, hied to Seattle, and sired Microsoft. In the succeeding years, Microsoft sold its BASIC to virtually everyone out there with a micro, including Apple and TRS.

### Boards and Acorns

During this time the company also cobbled other 8-bit and 16-bit languages, and created a piece of hardware that changed the face of microcomputing. Microsoft by then was cruising through the Z-80 CP/M market, leaving competitors in its wake. But the phenomenally successful Apple computers were based on an oddball chip, the 6502, that wouldn't run Microsoft's software. Allen decided to make a Z-80 add-on board that would soon have Apples by the hundreds of thousands purring with Microsoft programs. The remarkable fact here is that there are now more Apple CP/M users than those using any other microcomputer—and Apple wasn't even designed to use CP/M. Allen's SoftCard, and Microsoft's reputation as software mavens, sent ripples through the

industry.

One splash went clear across the country to IBM, which was hurriedly tinkering

**O**VER THERE  
is the mainframe  
wrapped around the  
next two versions of  
DOS and god knows  
what else.

with a new micro it internally called the "Acorn." Virtually nothing in IBM's computer was proprietary, except the overall design and the logo stamped on the front. Here the facts cloud somewhat. Microsoft's account, at least the one making the rounds, is that IBM knocked on its door wanting the standard dog and pony show.

This next item strains a whole lot of credulity, but according to one top MS staffer, Microsoft referred Big Blue to Digital Research. There is a Rosemary Woods gap in the tale here, and a short time later IBM came running back to the Pacific Northwest with an order for BASIC, an operating system, assorted other languages, utilities, and games.

Why does IBM hardwire BASIC into the PC? It obviously feels the language isn't going to just dry up and blow away. Neither do even the most ascerb microcynics. For one thing, there's nothing on the horizon to take its place. For another, BASIC is stuffed to the gunwales with goodies. Finally, it is still growing, evolving to meet the rigorous needs of today.

To find out more, PC decided to make the pilgrimage to Bellevue, Washington and consult the Guru of BASIC, Microsoft's Mark Chamberlin. Chamberlin is stamped out of the standard Microsoft mold: young, skinny, affable, articulate, whip-smart, industrious, circumspect. His office is at the very end of a crinkum-

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crankum labyrinth of corridors, and is tidy, almost spartan. The focus of the room is his DEC terminal, which beeps insistently every few minutes as urgent electronic mail snakes through the walls.

## DOS Under Glass

Microsoft's plant is a pair of clean, low-slung, modern offices that straddle a freeway. The locals give directions by saying "look for the big Ramada Inn; Microsoft's right in back of the Denny's restaurant." The buildings in that corner of Bellevue seem to float in tiers of parking lots crowded with Japanese cars. The cars all look spanking new. The buildings all look spanking new. The city gleams, even under the solid overburden of clouds. It is all white and sparkling glass. The people are cheery. They look you in the eye and say things like "howdy." This is all very disconcerting to a visitor from the east.

The staff at Microsoft is very security conscious. Thick, unmarked wooden doors pepper the halls. The receptionist makes a little badge for you with a head-

line-type machine. It says "visitor." You don't need the label. You end up gawking. Over there is the mainframe wrapped around the next two versions of DOS and god knows what else. In a corner are knots of whispering Japanese carrying small equipment cases I'd give plenty to peek into. Walking by are some awfully young executives who control the destinies of microcomputer owners of all denominations.

Through Mark Chamberlin's large picture window is the most incongruous spectacle of all: a little red farmhouse on a gentle hill, and a little red barn, with a little dog snapping at dragonflies in the little yard—a single lush acre of Washington state verdure hemmed in by terraced parking lots sporting ranks of Toyotas. Off in the distance Ma and Pa Kettle putter around on the sagging porch. Except that this particular couple are millionaires, having sold the back 39 to the Ramada people and the Denny's people and the Microsoft people. There are millionaires everywhere here.

## Chamberlin on BASIC

Chamberlin agrees that detractors find BASIC an easy target, and adds that in some ways the criticism is justified. He offered his thoughts in defense of BASIC, and told PC what Microsoft has in store in the future to counter such criticism.

\* \* \*

People who say "BASIC is not really a suitable language for doing certain things" are not looking at what BASIC is good for. What they're really saying is "I have a particular application, and maybe BASIC isn't all that suitable for doing it." But from the beginning, Microsoft BASIC—which we call GW-BASIC—has been the one language that has allowed the user to get to the new features of the machine. There is no other language that comes close to GW-BASIC in allowing users access to their hardware so well.

It's true that BASIC is to some degree unstructured, and this does allow people to write unstructured programs. But it certainly doesn't force them to. You can easily write structured programs. There are a

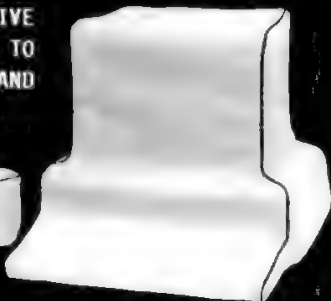
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few things missing at the present time in Microsoft BASIC. If we had those features—and we will have those features—then BASIC would quickly become a language that would encourage good, structured programming.

### Inside Story

What's missing? The most important thing is subroutines with local context: local variables and the ability to pass parameters to the subroutine. Local context also means that the line numbers are local to the subroutine. Also, it is important to be able to use alphanumeric labels as opposed to line numbers. As a practical matter, anybody who's written BASIC programs of any size knows that the line numbers can really be a problem.

There are versions of Microsoft that do support labels. It's certainly true of the Microsoft compiler, but I want to focus on the interpreter, because that is the product that most users see. And the compiler is intended to be just a means by which you can optimize the performance of your

BASIC program and also perhaps protect your source code.

What's also missing is simply an extended IF... THEN... ELSE. The way our IF... THEN... ELSE is defined, it is restricted by the line length; we have a limitation of 255 characters. I don't encourage packing as many statements as possible onto a line, which many people now

**C**OMPATABILITY  
*is an issue that has been  
at times a real problem  
for us.*

do; that is not a good programming technique. People use it because they know it's a little bit faster and they know that it conserves memory to some degree.

MS-BASIC allows you to "nest," to say

IF... THEN and insert multiple statements, and then ELSE... and then insert other multiple statements. But all of those statements have to fit on one logical line of 255 characters. The simple way to get around this is to use an IF statement that is followed by a THEN clause and an ELSE clause that can be on multiple logical lines. By doing that, you're in a position to write really structured programs. The fact is that you can achieve this same thing using a variation of the WHILE... WEND that is in our current BASIC, but it's cumbersome.

And even with those three major enhancements, there are still lots of smaller things we could do, all of which we are considering or working on. We can put in better debugging capabilities for example, although the current debugging tools are not too bad. You have Trace On (TRON) and Trace Off (TROFF) and can stop execution and look at your variables. But clearly the kinds of things you'd like to have would be devices to put a trace on a variable or set break points in the program

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and continue. Or output a trace to the printer. You can't do that now, and that's such a simple thing to change.

### High and Low

There are several main directions for BASIC. One is that BASIC has to become more structured and have better program development features for people using it as an implementation language to create such things as business packages. People have actually written applications programs such as general ledgers in BASIC. The real key to success for a software house is to write programs that are portable. And obviously, the way to do that is write them in high level languages. Microsoft BASIC is available on virtually every desktop machine. For a while there was a slight absence of Microsoft products at the very low end, but I think we're making a strong comeback there, particularly with our new MSX. So there's a real incentive for program developers to write programs in Microsoft BASIC, but of course they sense some of the things that are lacking

that I've already spoken of. And to move in that direction, Microsoft BASIC has to add those features.

BASIC doesn't have things like Find

**T**HERE ARE  
all sorts of rumored  
optimizations that  
simply don't work.

and Replace and a full screen editor instead of a line-oriented editor. And that's one direction that our BASIC is heading—toward a higher level of sophistication and ability. On the other hand, there's still a market at the very low end where you can do amazing things in a ten- or twenty-line BASIC program, and I think there will always be a class of users interested in doing that.

Here's an interesting question: What defines the specifications of a language—what the language will do on a given implementation or the documentation that comes with it? Many users claim it should be the former, and that's what it comes down to, but I honestly believe it should be the latter. What's happened over the years is that Microsoft BASIC has been released in a large number of machines and each implementation may have some anomalies—not bugs per se—but rather, hidden features. People find these things and start using them. This causes some pretty severe problems in terms of compatibility.

And compatibility is an issue that has been at times a real problem for us. For example, people write programs in our BASIC for the IBM PC and they use things like PEEKs and POKEs. You can't move that program over to another machine and run the GW-BASIC and expect it to work properly. It's really amazing to me how many programs written that way are in widespread distribution.

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PC MAGAZINE 336 SEPTEMBER 1983



When people first started porting their applications to the IBM PC, they were in a hurry, and they wanted to exploit the features of the machine. They weren't thinking in terms of the greater MS-DOS market. Now those developers are probably realizing that there is a whole class of machines here, not just the IBM PC. What developers really ought to be doing is writing GW-BASIC-compatible programs, not just those for the IBM PC.

But to the degree that any BASIC features are undocumented, I'm actually in favor of their remaining undocumented. We really have a commitment to maintain compatibility with the ones that are documented. Programmers using the features that are not documented will have to pay the price if they ever want to move that application.

#### Undocumented Woes

By using these undocumented features, programmers make it impossible or difficult for us to be innovative. There are enough of these cases where there have actually been problems. GW-BASIC has been moved to quite a few so-called IBM compatible machines, and there's been a substantial effort on the part of those manufacturers to determine what programs run and what programs don't.

**I** DON'T  
know of any language  
available today that  
has a better debugging  
interface than our  
BASIC.

We don't have our own compatibility test. The reason for this is that we no longer are in the business of porting GW-BASIC to specific hardware. That work is done by the original equipment manufacturer (OEM). We took our GW-BASIC and defined a machine-independent interface to that BASIC. When an OEM customer licenses GW-BASIC, we give him a kit that contains the object code in relocatable modules for a high level code of BASIC, as

well as a specification for low level routines that support the hardware-dependent features of the language.

Users are constantly finding simple undocumented hints that can save execution time—like saying FOR A=1 To 10... NEXT rather than FOR A=1 to 10... NEXT A. For a long loop the first way is

faster. This development falls into an interesting category, along with things like packing as many statements as you can per line, leaving out remarks statements, putting subroutines at the top, and defining the variables that you use most often at the beginning of the program.

It's unfortunate that people have to be



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aware of things like the fact that programs will run faster if you leave the spaces out. As a practical matter, omitting spaces will speed up a program. This has been influencing programming styles, and I'd say adversely. Should you use NEXT A or just say NEXT? From the point of program legibility it's better to say NEXT A.

There are all sorts of rumored optimizations that simply don't work. For instance, with earlier versions of BASIC, even some in use today, a program runs faster if you use shorter line numbers. But it's not true with the IBM PC.

### Step and Fetch It

Speed is not always the most important factor in programming; it depends on the nature of the application. I would never write a program using those optimizations mentioned above. If I felt that it was necessary to get all the speed possible, I would write the program in as structured a form as I possibly could; then run it through a compression program. People do this all the time; the second program

takes all the remarks and unnecessary spaces out of the first program, and performs other time-saving tricks. For instance, if you use long variable names in the interpreter, you're going to pay both in terms of size of your program and in speed. The interpreter does truncate variable names automatically, but only at 40 characters; not too many people are running into this limitation.

There's a case where we know we need to make an improvement. Using variable names that are longer than two or three characters is a very good idea in terms of legibility and maintainability of the code. What comes out of compression programs is a fairly cryptic-looking BASIC program but it runs faster, and programmers don't suffer the consequences of having written it that way in the first place. They still maintain the source code of a program that has remarks and indentations and says NEXT A rather than NEXT.

Should Microsoft publish a book that tells users whether it's best to put subroutines at the beginning of the program? I

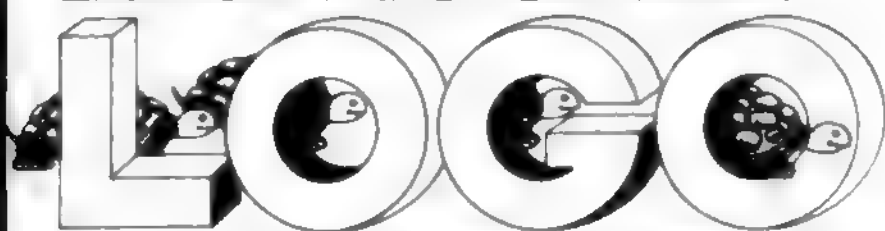
have mixed feelings about that because I don't want to embrace any such programming standards. I want to believe that people can write good programs without having to worry about implementation details, and it's my job to make sure that the language allows them to do that. We haven't met that goal 100 percent yet. But we certainly will in the desktop PC environment. People will be able to write programs without having to worry about increasing speed by using such tricks.

With micros, the most important idea is to make BASIC a better development language for applications. That's not to say we're not going to aim for any innovation in terms of end user features—such as enhanced graphics and sound capabilities—because we certainly will.

### STOP on a Dime

There are definitely some debugging improvements that can be made in terms of indicating where the errors are. Pointing to the errors is important, as is being able to separate points in the program.

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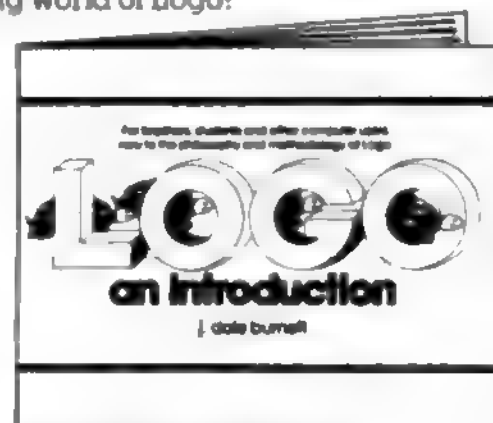
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You can actually do that now; you can add PRINT statements that will trace your variables, and you can insert STOP statements. But that's not good enough because you want to be able to do it without having to start the program from the beginning each time.

One of the things that will come in a future version is the ability to just say STOP on a particular statement when you arrive there, or execute 10 statements and STOP again, or STOP when a certain variable is modified, or just PRINT a specific variable out every time it's modified. Those are things that would make the interpreter far more valuable for debugging programs.

I don't know of any language available today that has a better debugging interface than our BASIC. To fix a problem with a compiled language, you have to go back to the source code and put in PRINT statements and then recompile and link and execute and half an hour later maybe you'll have an answer to what was wrong. It is true that we can make interpretive

BASIC much better than it currently is, but I certainly think it's the only practical way to debug. If you write a BASIC program you should develop it with the interpreter, and if you are concerned about speed you should then compile it.

## **P**EEK AND *poke really ought to be reserved for special occasions.*

Most of the people who write articles about "Why BASIC is a Bad Language," are generally computing professionals, (or self-appointed computing professionals). But PC purchasers who have never programmed before are going to love Microsoft BASIC because it will let them get to the full power of their machine in short

order. And I just don't know of any other way they are going to do it. Those people are not going to go out right away and read Pascal manual—not that I'm saying there is anything wrong with Pascal as a language; it's a good structured language but it isn't for novice programmers. Unless you're going to argue that only programmers should program computers, then you can't make the argument that BASIC is a bad thing because it allows nonprogrammers to program. That should be viewed as a good thing.

One problem for many programmers is the state of the documentation. There are certainly programming aids that can be implemented inside BASIC but there are limitations to how many. On-line tutorials about BASIC are quite good—a good concept. Although I think it could be somewhat helpful to build help into BASIC, it's not realistic to think that doing so will give novices enough information to learn how to program.

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type a question mark, the computer will show me all the commands that start with that letter. Once I've typed a command name I can type a question mark again and it will show me all the possible things that can follow legally. We can do that in

**B**ASIC HAS  
a fairly long life  
expectancy.

BASIC and we may very well do it. But I seriously doubt whether that will be sufficient as an instruction device; it's there really just to remind the user who is already familiar with the system. It's not going to teach novices how to program.

## Dangerous POKES

One of BASIC's real strengths is its ability to develop programs quickly and interactively. For writing utilities that do translations on files, the string capabilities in BASIC are really very good. Sometimes I'm amazed at how fast you can develop a program like that.

In some ways I wish that we didn't offer the ability to PEEK and POKE; they are very useful but they're dangerous, and people tend to use them more than they should. They really ought to be reserved for special occasions.

One problem we face is what to put in our manual to make such an advanced feature clear. How do we explain in detail what something like the INP function does? I always say—and maybe this is a bad attitude, but I don't think so—that if someone is going to use something like INP, he will have to know enough about what he is doing that we don't need to make the explanation any clearer. To have a tutorial on how to use INP is ridiculous because it's not something that someone who is at a beginning level should be playing around with. In order to come up with realistic examples—and I think you do have to include examples when you have a tutorial—you will lose that novice user just in developing the example to explain what INP or PEEK and POKE are used for.

I'd much rather put features into BASIC to support such things than to tell



somebody to use PEEK and POKE. What it really comes down to is that when you incorporate such advanced statements and functions into your program, you're not writing a BASIC program anymore; you're writing an assembly language program. And there is no way to explain these things easily; it's a whole separate topic. I don't feel any remorse over the neophyte user's not being able to understand exactly what to do with PEEK and POKE.

I think the right direction here is to create utilities that allow the user to experiment and write effective programs without getting down to the bit level. It's definitely a good idea, and it's something Microsoft has considered.

### BASIC Fan Mail

Will another language come along that will supplant BASIC? I don't know. Remember that while everyone hears complaints about BASIC, the people who are doing the complaining are not the average end users. End users are generally very pleased; we even get fan mail.

And what other interpretive language could offer the features of MS-BASIC? Not LOGO at this stage of the game. It's okay for drawing pictures. And educating children, because in the course of drawing those pictures, they learn some valuable concepts. I think that BASIC has a fairly long life expectancy; I don't think that anything's going to replace it. But I think there is a possibility that the day will come when people won't be so concerned about programming languages anymore.

People program for two reasons. First, because they have an application or some need and there's no software available to do the job. This will change because as more software is available and as applications become more intelligent and more user configurable, the need for the user to do his own programming will vanish.

The second reason people program is because they love to do it. It's quite evident that this reason is not going to go away. People who have no practical reason to do so still write programs in assembly language. There's no explanation for

this other than it's a lot of fun. Microsoft BASIC lets you get at the power of the machine. I can do things in Microsoft BASIC that I could otherwise do only in assembly language.

\* \* \*

Mark Chamberlin doesn't have to sell me on BASIC; I can't get enough. The wrinkle, however, is that Microsoft is said to be in the process of translating most of its software from 8086 assembler into C. So is just about everyone else in the business, including MicroPro. It sure looks from here as if in a year or two we're all going to be using some sort of Unix/Xenix operating system (written in C, of course), doing applications programming in C, and having fun with BASIC. And now that Microsoft has picked up Lattice's highly regarded C, Bellevue, Washington will be your one-stop programmers' shopping center. The folks from DRI aren't so sure. Or the crowd at Watsoft, or the few other language factories. And there is a hush-hush development in the works that may really shake things up. Stay tuned. /PC

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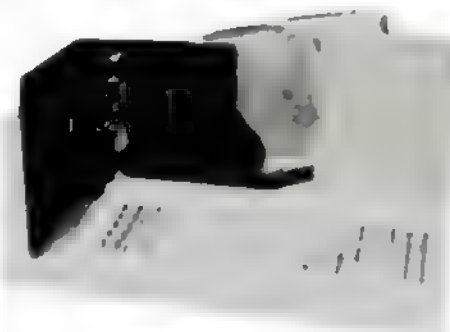
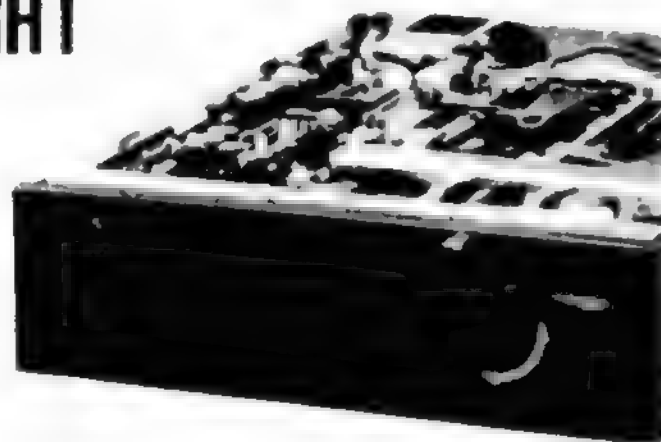
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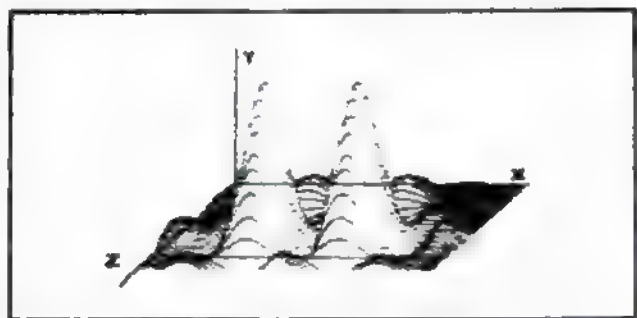
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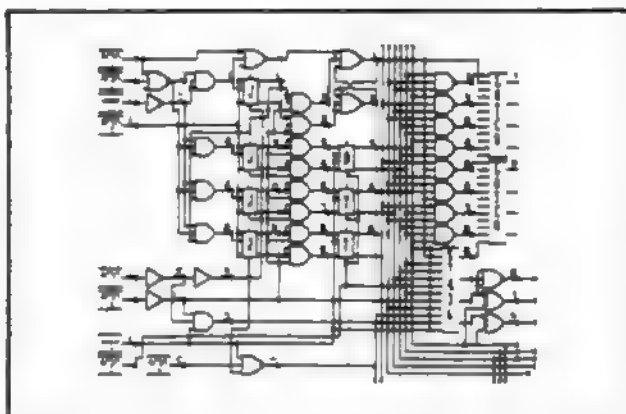
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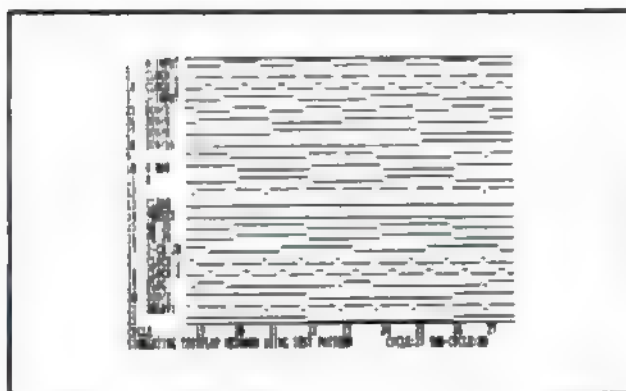
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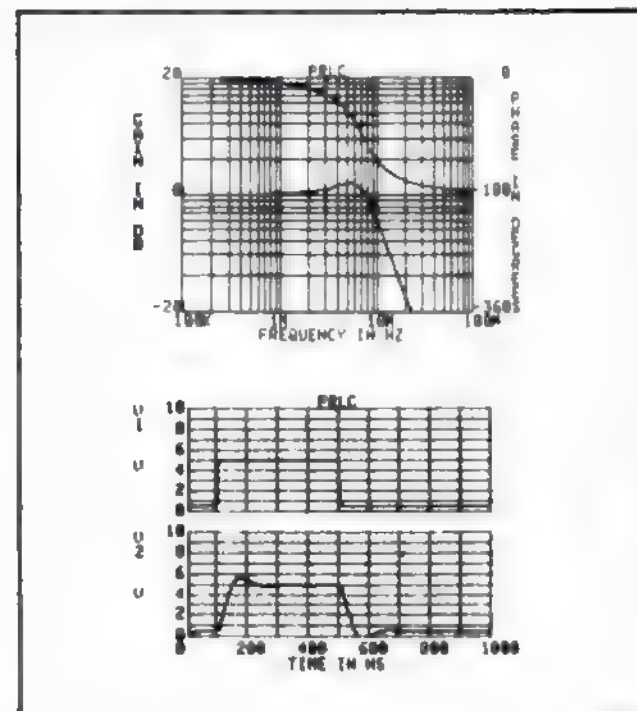
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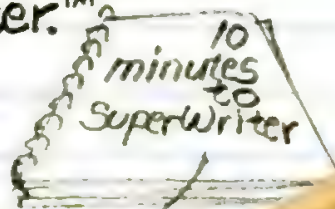
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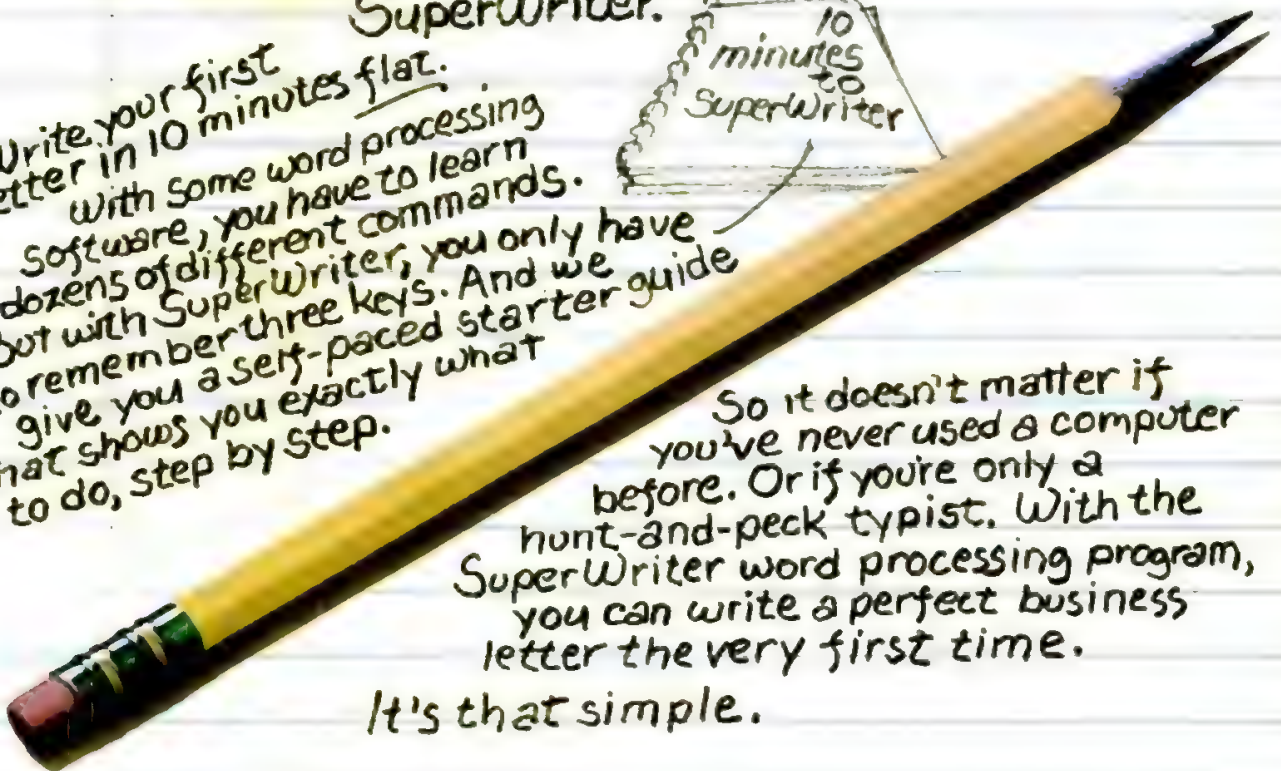
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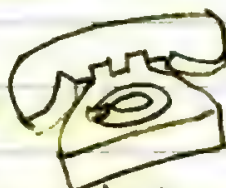
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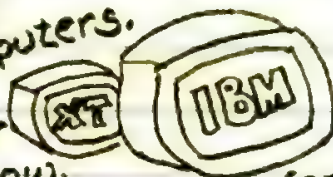
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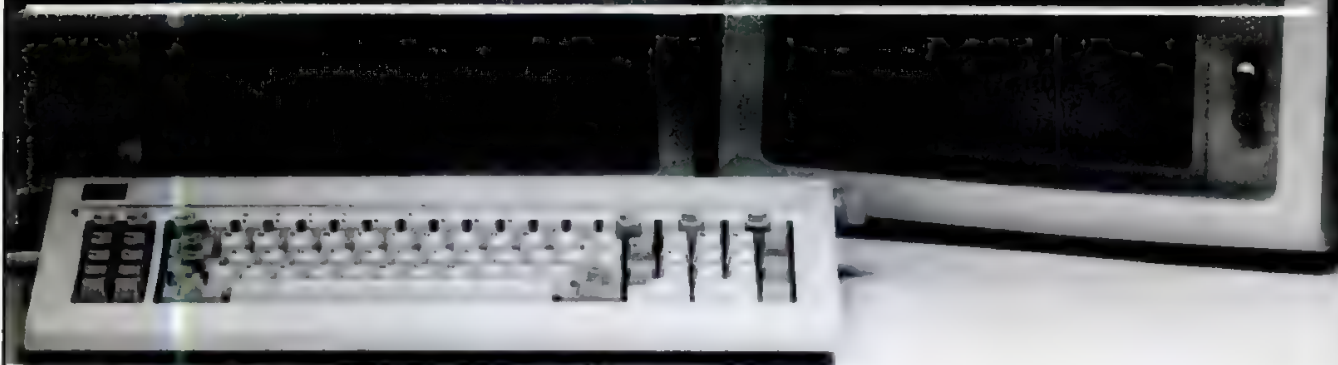
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Development System becomes an invisible addition to your familiar disk BASIC. Yes, there's also a BASICA patch, and another one for use with DOS 2.0. The seven BDS modules are as follows.

- **XBASIC**—Keyboard shorthand functions and debugging aids.
- **XREF**—A cross-reference for variables, line numbers, and numeric constants.
- **FIND**—A cross-reference for character strings and BASIC keywords.
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The XBASIC module offers 11 single-initial commands that may be used in the direct mode. When one of these initials is typed as the first character in a line, it will

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function as if a complete word had been typed in. These command abbreviations are the first letters of Auto, Cls, Delete, Edit, List, Load" (enter L"), Merge, New, P (= LLIST), Save, and Un-NEW. The Un-New command restores a program accidentally erased by typing NEW.

Entering a period as the first character will list the current program line, while PgUp and PgDn list the previous and the next program line, respectively, Ctrl-PgUp and Ctrl-PgDn will list the first and last

Figure 1: Features of the XREF and FIND modules. Various listings can be displayed by using BDS's XREF and FIND commands.

X.	lists all variable references to the screen
X.	lists all variable references to the printer
X.p	lists all variable references, starting with p
X p	lists references to p only
F.	lists all BASIC keywords and tokens
F,"kw	lists all keyword references, starting with kw
F "kw	lists references to kw only
F."ss"	lists all string references starting with ss
F "kw1+kw2	lists only those lines in which kw1 and kw2 appear
F "kw1,kw2	lists references to kw1, and these are replaced with kw2
F	displays the contents of the next line containing a reference to a previous F "kw or F "ss" command

Figure 2: The BDS SAMPLE.BAS program

```

10 'This is a REMark
20 DEFINT H,I
30 DBL.PRECISION# = 4#
40 HEX.VALUE = &HFFFF
50 B.STRING$ = "This is a string"
60 SNG.PRECISION$ = 5000000!
70 IF DBL.PRECISION# > SNG.PRECISION THEN GOTO 150
80 DIM ARRAY (4)
90 FOR INDEX% = 1 TO 4
100 ARRAY (INDEX%) = INDEX% ^ 2
110 NEXT INDEX%
120 GOTO 150
130 A.STRING$ = "This is a string" + ", too!"
140 YEAR = 1982
150 PRINT "End"
```



program lines.

The final command within the XBASIC module is SYSTEM TRON, a Trace On command with a difference. Instead of filling the screen with line numbers, a single line number is displayed in the upper right-hand corner, and program execution halts until a key (any key) is struck. Then the next program line is executed, its line number is displayed, and the program halts again. Thus it's possible to step through an entire program line-by-line, while keeping an eye on program flow. By holding any key down, the program is executed at the normal keyboard repeat rate. So, in a long program it's easy to skip ahead quickly and slow down when and where needed. Typing SYSTEM TROFF will disable this single-step trace mode.

SYSTEM TRON and SYSTEM TROFF may also be used within a program, as in this example.

200 IF A = 4 THEN SYSTEM TRON

The XBASIC features are convenient; the user takes them for granted almost immediately. However, it's the other modules that really show off the BASIC Development System. For example, XREF and FIND display various listings, as shown in Figure 1.

Note that a period provides a screen listing, while a comma is used for a hard-copy printout. "kw" is any BASIC keyword or token (IF, THEN, +, =, etc.) and "ss" is simply any character string.

To illustrate the X and F modules, try the following lines:

30 PS = "A string variable"

Figure 3: Typing F. in the BDS SAMPLE.BAS program lists all keywords and tokens.

+	130						
=	30	40	50	60	90	100	130
>	70						
DEFINT	20						
DIM	80						
FOR	90						
GOTO	70	120					
IF	70						
NEXT	110						
PRINT	150						
REM	10						
THEN	70						
TO	90						
.	100						

Figure 4: Typing X. in the BDS SAMPLE.BAS lists all variables.

1	90				
2	100				
4	80	90			
1982	140				
5000000!	60				
4#	30				
&HFFFF	40				
*150	70	120			
A.STRING\$	130*				
ARRAY(	80	100*			
B.STRING\$	50*				
DBL.PRECISION	30*	70			
H	20				
HEX.VALUE	40*				
I	20				
INDEX%	90*	100	100	110	
SNG.PRECISION	60*	70			
YEAR	140*				

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40 Q\$ = "An unlikely string variable, containing %P\$3.2"

Typing X P\$ will display P\$ 30\*, indicating that the variable P\$ is found in line 30. The asterisk (\*) will be explained shortly. P\$ also appears as a character string in line 40, but this can be ignored. And, so typing F "P\$" finds the P\$ character string in line 40, while ignoring the variable of the same name in line 30.

To further demonstrate these and other BDS modules, the SofTool disk contains the SAMPLE.BAS program shown in Figure 2. (SofTool suggests investing little or no time trying to understand this program, since it does absolutely nothing other than show off the system). Figures 3 and 4 display the printer listings produced by the F and X commands.

In Figure 4, the asterisk preceeding listing 150 indicates that this is a reference to a line number. The asterisks following the references in columns 2 and 3 indicate that the value of the variable in question is changed at these line numbers. Thus the value of INDEX% is changed in line 90,

while INDEX% appears (unchanged) three more times, twice in line 100, and once in line 110.

The VARIABLE DUMP module dis-

**S**UPER RENUM seems to be goofproof, and will not overwrite an existing program line even if you try.

plays some or all variables, along with their current values. This can be especially valuable for displaying numeric variables that are not otherwise seen. For instance, your final value for, say, P2 is based on a calculation in which YEAR is supposed to equal 1941. However, typing V YEAR displays 1982. Something's

wrong here. How did YEAR get to be 1982 when it should be 1941? Try typing X YEAR. If you get back YEAR 140\*, you're on the right track. That's the line in which the value of YEAR got changed.

SUPER RENUM offers all sorts of enhancements to the familiar RENUM command. In fact, program lines can even be resequenced; try this one.

```
10 'first line
20 'second line
30 'third line
40 'fourth line
50 'last line
R15, 1, 30, 40 [ENTER]
10 'first line
15 'third line
16 'fourth line
20 'second line
50 'last line
```

In other words, lines 30 to 40 were

Figure 5: The BDS SAMPLE.BAS program listing after going through the COMPRESS and UNCOMPRESS modules.

```
COMPRESS module
20      DEFINT      H,
I:DBL.PRECISION#=4#:HEX.VALUE
=&HFFFF:
B.STRING="This is a string":
SNG.PRECISION=5000000!:
IF DBL.PRECISION#>SNG.PRECISION
THEN 150
80 DIM ARRAY (4): FOR INDEX =1 TO
4:ARRAY (INDEX)=
INDEX2:NEXT INDEX:GOTO 150
150 PRINT "End
UNCOMPRESS module
10      DEFINT H, I
20      DBL.PRECISION# = 4#
30      HEX.VALUE% = &HFFFF
40      B.STRING$ = "This is a
string"
50      SNG.PRECISION! =
5000000!
60      IF DBL.PRECISION# >
SNG. PRECISION! THEN

70      DIM ARRAY! (4)
80      FOR INDEX% = 1 TO 4
90      ARRAY! (INDEX%) = INDEX% ^2
100     NEXT INDEX%
110     GOTO 120
120     PRINT "End"
```

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moved to a new location beginning at 15, and incrementing by 1. Typing R 30,10,15,16 will get you back to the original sequence. Typing R I (a,b,c,d) will duplicate (at line a) the program block defined by the last two numbers (c,d), without

removing it from its original location. R U scans the program for undefined lines, without renumbering the program. SUPER RENUM seems to be goofproof, and will not overwrite an existing program line even if you try. Instead, you get an

error message, and the listing remains unchanged.

Once your program is up and running, COMPRESS will squash it to a minimum size, removing unnecessary blanks, extraneous colons, LET keywords, GOTOs following THEN or ELSE, etc. It also merges multiple statements into single lines, and removes remarks, variable names from NEXT statements, and lines that never get executed (such as 130 and 140 in the SAMPLE program). Most of these options can be turned on and off as needed. For example, H LR preserves remarks and nonexecutable lines.

UNCOMPRESS puts a compressed program back into a more-readable format (see Figure 5), although it doesn't restore remarks. (SofTool would like to hear from anyone who can figure out how to do that little trick. Call collect.)

MANUAL. No, it's not another module. It's the documentation, and it's really strange. Obviously, the SofTool folks know nothing about the proper method for doing these things. This manual is written in English, a language rarely used for software documentation. The problem with English is that too many people understand it, and it makes the BASIC Development System look like it's doing something that's ... well, understandable. They should have talked to me first. I'd have told them to toss in some DEF SEGs, a couple of USRs, and a six-pack of PEEKs and POKEs. That way they could have baffled more of us, and probably charged three times the price.

### BASIC Programming Tools

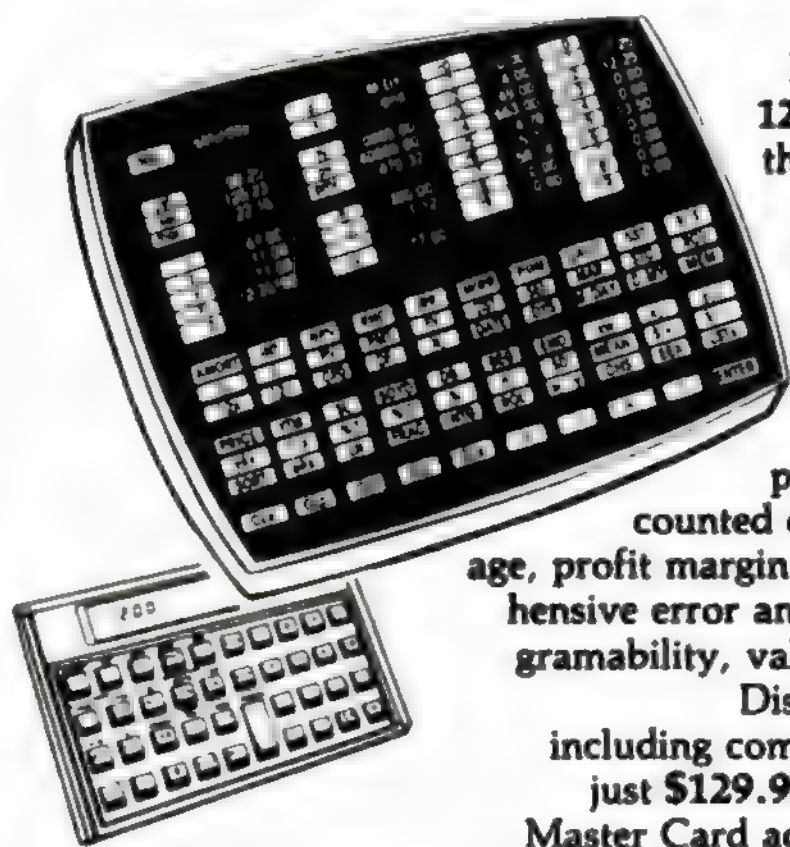
From Synergistic Software comes a set of five programming aids for the IBM-PC called BASIC Programming Tools. About the only thing that BPT and BDS have in common is that both packages are designed to make BASIC programming a little easier—all right, a great deal easier. There, most of the similarity stops. BDS becomes an integral part of your disk's BASIC.COM system, and once its been patched, the modules are as accessible as any of the usual BASIC vocabulary.

By contrast, the BASIC Programming Tools are, and remain, five separate BASIC programs, all of which are assumed to be on the default disk drive. The programs are called EDIT, NUMBER, UNNUMBER, SUPER LISTER, and STRIP, described in the manual as follows.

Figure 6: Example of BPT EDIT program. The program is written without line numbers and saved as an .SRC file, and the NUMBER program creates a numbered ASCII file. (Note that line 50 has replaced the {CALCn} labels with the appropriate line numbers.)

A = 2	10 A = 2
B = 4	20 B = 4
C = 6	30 C = 6
input k	40 INPUT K
on k gosub {CALC1}, {CALC2}	50 ON K GOSUB 80,110
print p	60 PRINT P
end	70 END
CALC1 '... first routine	80 '...CALC1. first routine
p = c * b	90 P = C * B
return	100 RETURN
CALC2 '... second routine	110 '...CALC2. second routine
p = b - A	120 P = B - A
return	130 RETURN

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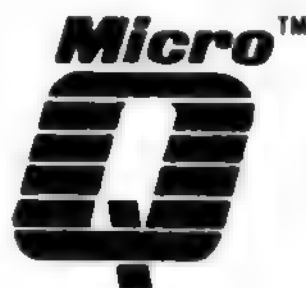
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## THE TOWER OF BABEL CONQUERED!

• **EDIT**—A full-screen text editor, designed as a replacement for EDLIN.

• **NUMBER**—Converts a source file written without numbers to an executable BASIC program.

• **UNNUMBER**—Removes line numbers and substitutes line labels as required.

• **SUPER LISTER**—Produces an enhanced listing (screen or printer) of a BASIC program file.

• **STRIP**—Analogous to BDS's COMPRESS module.

When writing a BASIC program, how do you decide on a line number for your first, second, or for that matter, tenth, GOSUB or GOTO? Do you write the subroutines first, or just choose a number sufficiently far away to stay out of trouble? Whatever you do, it's a pretty safe bet that sooner or later you'll get into a bit of RENUM trouble.

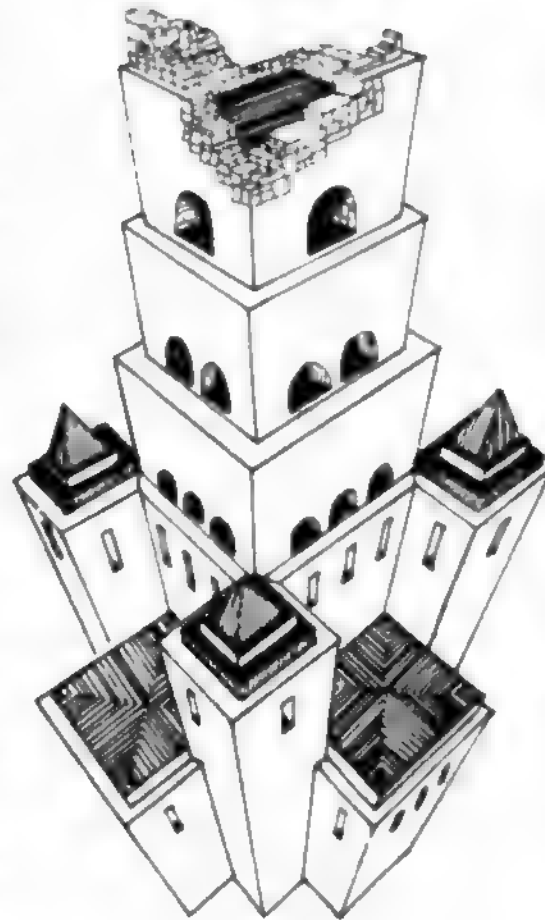
You can avoid all of this with BPT's EDIT program, in which you write in BASIC without using line numbers. For example, if you need some calculation subroutines, just write something like ON K GOSUB {CALC1},{CALC2} and then write the subroutines with a line beginning CALCn ' .(optional name), as shown in Figure 6.

**THIS MANUAL**  
is written in English, a  
language rarely used  
for software  
documentation.

The BPT editor reassigns the function keys, and displays the new labels across the bottom of the screen. (These may not be removed by typing KEY OFF.) The first four function keys scroll the text up or down by one or four lines (F1 = 1 line up, F4 = 4 lines down, etc.). F5 splits the current line into two lines, beginning at the cursor position, while F6 joins the next line to the end of the current line. F7 retrieves the last line removed, while F8 retrieves all lines recently removed. F9 removes a single line, and F10 inserts a blank line. Figure 7 gives a few examples

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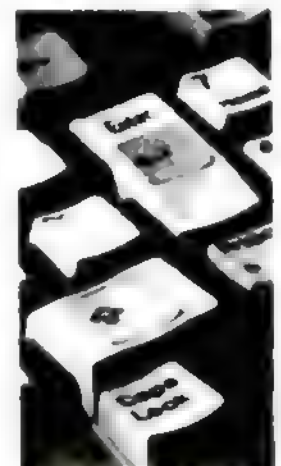
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Figure 7: Examples of some of the function keys in BPT's EDIT mode.

Pressing F5

A = 3.14 \* B: PRINT "A = "; A  
becomes

A = 3.14 \* B  
PRINT "A = "; A

Pressing F6

X = 4 - B: \_  
Y = 27 + X  
becomes

X = 4 - B: Y = 27 + X

Pressing F9

A = 10  
B = 20  
C = 30  
becomes

A = 10  
C = 30

Pressing F10

A = 10  
B = 20  
becomes  
A = 10  
B = 20

of the use of these functions.

With the exception of the first line of a subroutine, all program lines must be indented a few spaces. This is no problem, since a single stroke of the Tab key sets a new left margin, which remains in effect until you use the back-Tab function (shifted Tab).

Once the editing is done, you must exit the EDIT program (Esc U) and then run the NUMBER program to find out if your program works. These actions create a source file (.SRC) containing the unnumbered program, and an ASCII file (.ASC) containing your program with line numbers, as seen in Figure 6.

At this point the user may have second thoughts about the advantages of writing unnumbered programs. For a relatively complex editing job, the potential power of BPT's EDIT mode is obvious: You don't have to bother keeping track of where all your subroutines are. However, one little typing mistake in the EDIT mode can produce some baffling surprises during NUMBER. For example, let's say in Figure

6 the comma between the braces in ON K GOSUB {CALC1} {CALC2} was omitted. Since the NUMBER program puts CALC1 at line 80 and CALC2 at line 110, line 50 now becomes ON K GOSUB 80110. Assuming there is no line 80110, and that K = 1, you get an error message (undefined line number in 50), which at least lets you know where the trouble is. However, if K = 2, the program does not branch to line 110, and it may take a lot longer to spot the error.

Referring again to Figure 6, if the space between CALC1 and the single quote had been omitted during EDIT (CALC1'. etc.), then the NUMBER program will produce the error message "CALC1 undefined in

***T***HE PROBLEM  
with English is that too  
many people  
understand it, and it  
makes the BASIC  
Development System  
look like it's doing  
something that's  
understandable.

line 50." If you run the program, you'll get a syntax error, and line 50 will read ON K GOSUB {CALC1},110. Well, that certainly is a syntax error, but it was caused by a typing error elsewhere—that is, on what is now line 80. However, line 80 now reads ROUTINE, and your actual typing error has disappeared!

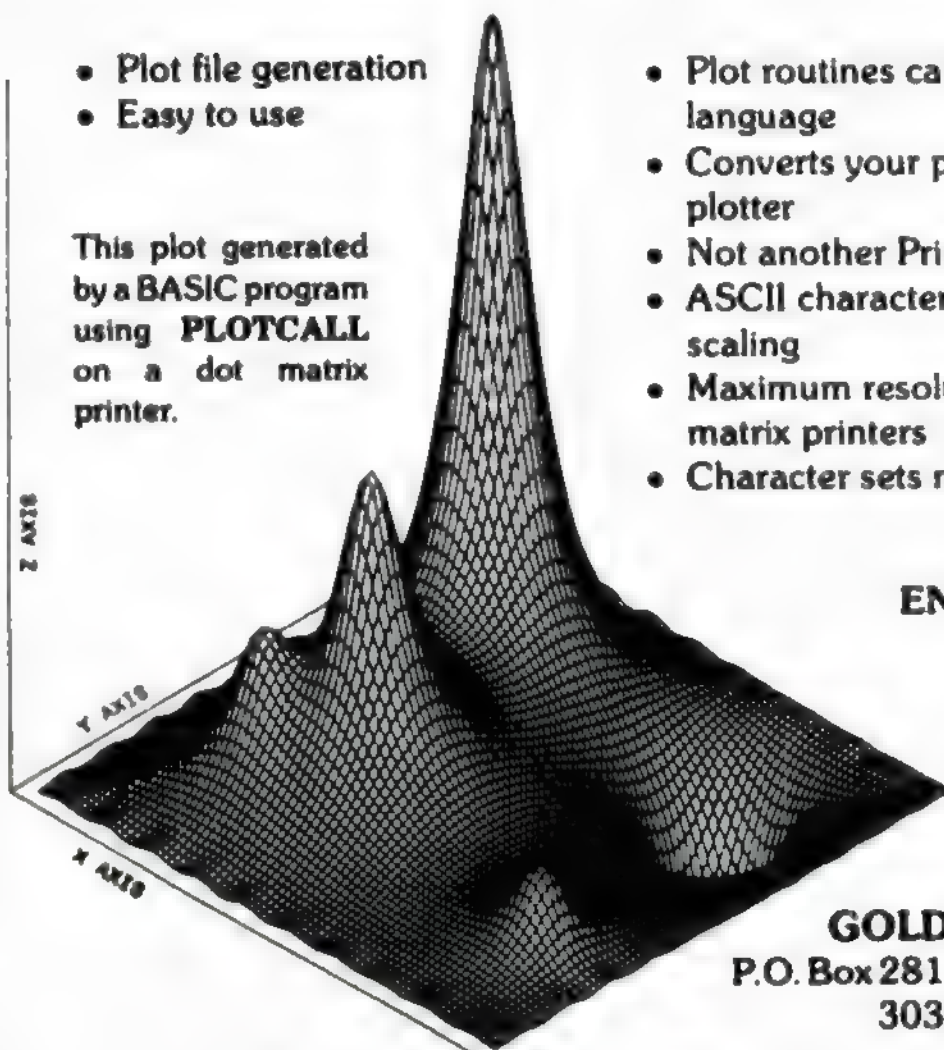
To quote from the BPT manual, "At this point, you have to make a decision about corrections. If you modify the .ASC file using BASIC's built-in editor, your .SRC file may become obsolete. If you go back to the .SRC file to make every little change during testing, you waste a lot of time."

To me, one of the charms (and frustrations) of BASIC is instant feedback. Of course, the feedback is not always positive, but at least one doesn't have to go through a compiling-like process to find out that the program doesn't work anyway. Although it may not be considered

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elegant programming, it's usually possible to debug simply by running the program and keeping an eye out for derailments. By forcing a two-step editing process, BPT's EDIT program introduces some BASIC programming tradeoffs that will appeal to some, but by no means all, programmers.

There are a few important points that are not all that clear in the manual. For example, "EDIT asks for a filespec ... which may include a filename extension." Change that to read, "... must include an .SRC extension." If you don't include the .SRC extension, the NUMBER program will not be able to find your file and number it.

When you're finished editing, your options are New, Old, Run, or System. The first two permit more editing. Run can't be used yet (since you still haven't numbered the program), and System takes you back to DOS. To avoid this, just type R and specify a nonexistent file. This gets you a "file not found in 680" error, but at least you remain in BASIC and can run the NUMBER program.

As a final EDIT precaution, the manual suggests using the EDIT.HLP file to familiarize yourself with the edit commands. However, if you follow the directions, this

make the program more readable. Second, it lists all the variable names in alphabetical order at the end of the program listing. To demonstrate the variable-name listings, SL was used with the sample program on SofTool's BASIC Development System disk, and the results are presented in Figure 8. (For comparison with SofTool's X module, see Figure 4.)

At the user's option, the SL listing may be directed to an output file, a printer, or the screen. If you choose the screen option, you'd better brush up on your speed reading, since the listing disappears almost as fast as it is displayed. To keep the screen listing long enough to study it, add the following line to the SL2.BAS program:

```
2479 INPUT "Press any key to continue.",KK
```

```
Or, change line 2480 to read
2480 IF LEFT$(LD$) = "L" THEN PRINT CHR$(12);
```

Finally, add the following line to keep the whole works from vanishing before you're finished.

```
2145 INPUT "Press any key to conclude.",KK
```

The final BASIC Programming Tool is the STRIP program; it deletes ASCII-file remarks beginning with a single quote ('), leaving only the single quote. Statements

Figure 8: BPT's SUPER LISTER program.

```
SAMPLE 07-04-1983 12:44 *CROSS
REFERENCES*
VARIABLE REFERENCES (* INDICATES
LINES WHERE CHANGED)
A.STRING:          130*
ARRAY():  80*      100*
B.STRING$:         50*
DBL.PRECISION#:    30*   70
HEX.VALUE:         40*   110
INDEX%:   90*      100   70
SNG.PRECISION:     60*
YEAR:           140*

"LINE REFERENCES (* WHERE REFER-
ENCED BY GOSUB)
150:   70   120
```

## ONE OF THE charms (and frustrations) of BASIC is instant feedback.

file becomes part of your program, and makes numbering and subsequent running impossible. It is probably simpler to use the quick reference chart on page 21 of the manual instead.

### Other Programming Tools

The next programming tool is UN-NUMBER, which simply unnumbers an ASCII file and creates an .SRC file, which may be edited and (re)numbered as described above.

SUPER LISTER (SL) does two things. First, it produces an enhanced program listing with indentations and spaces to

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Figure 9: In this example of "pretty printing," the careful vertical alignment of the equal (=) signs does not survive the BPT SUPER LISTER program.

```
5 'note layout of FOR, NEXT loop
10 FOR TEST = 1 to 10
20     Z = 3 * P
30     L(1) = X - A
35     = 'This is a remark
40     Z$(A) = A$(P - A)
50     IF K = 4 then J = M - 3.4
60 NEXT TEST
```

becomes

```
5 'note layout of FOR, NEXT
loop
10 FOR TEST= 1 to 10
20     z = 3*P
30     L(1) = X-A
35     'This is a remark
40     Z$(A) = A$(P-A)
50     IF K = 4 then J = M-3.4
60     NEXT TEST
```

beginning with REM are not affected. STRIP also removes unnecessary blanks, after which the program is saved with an .STP suffix.

Next, the .STP program is loaded. Simply hitting the Enter key will save it as a BASIC (non-ASCII) file and also kill the .STP file. Or, if you like, save them both.

I agree with the BPT manual that, "Perhaps the most useful programming tool of all is EDIT." If you like what it does, then BPT is well worth the money, and the other four programs simply come along as part of the deal. If you don't plan to use EDIT, there's not much point in having NUMBER and UNNUMBER. SUPER LISTER is okay, but it's a great deal slower and not as complete as BDS's F and X modules, as the Figure 6 comparison shows. And if you really want a super listing, you may have to do it yourself anyway. As Figure 9 illustrates, SL may not always be an improvement. In conclusion, STRIP is not nearly as thorough as BDS's COMPRESS module.

Summing up, after a few days with SofTool's BASIC Development System, I wonder how I ever got along without it. Being able to type L, C, or N, instead of LIST, CLS, or NEW may not qualify as one of the great breakthroughs of the computer

**SUMMING UP,**  
*after a few days with  
SofTool's BASIC  
Development System, I  
wonder how I ever got  
along without it.*

age, but it's nice—very nice indeed. And so are the rest of the BDS goodies. This set of tools should be in everyone's software library.

While the BASIC Development System might fall under the heading, "instant gratification," BASIC Programming Tools is more of an acquired taste. The EDIT program is its star attraction. If you've come to BASIC from a Pascal background, you'll probably take to it immediately. However, if BASIC is your only language, unnumbered programming may take a little getting used to. It does eliminate some of the binds of conventional numbered programs, but SofTool's SUPER RENUM module does too, and with less relearning required.

Once mastered, BPT's function key assignments are great for debugging chores, especially the Split and Join keys. It's also handy to be able to move lines into the copy buffer, and transport them to other locations within the program. Once again though, you can do pretty much the same thing in regular BASIC by overstriking the line numbers.

For programmers at my level of expertise (sub-basement, behind the oil burner), acquiring the BASIC Development System is a definite must, while the Basic Programming Tools is a definite maybe. It is not likely that with experience the user will outgrow the BDS, but it is possible that with that experience, the capabilities of BPT's EDIT program may become even more appreciated. How's that for a tight conclusion?

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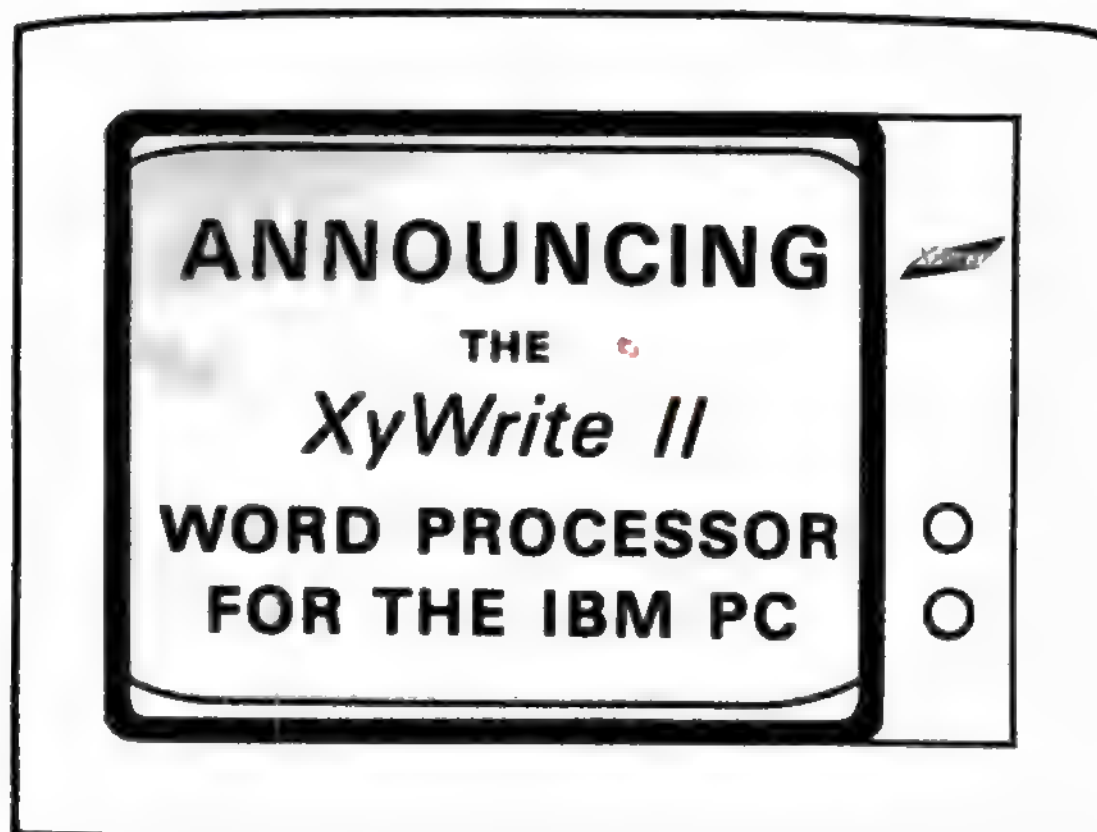
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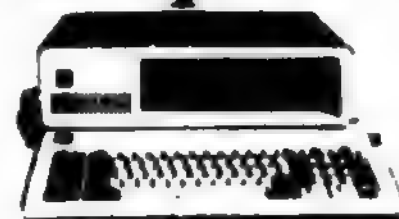
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FormManager's unique forms-editing capability allows you to lay out forms on the display any way you want; without programming, without any restriction. You can even draw lines and boxes with only three key strokes. Its data validation features catch errors when data is filled in. You can even specify default values (such as "San Jose" for city) to save typing.

### Powerful data management.

Unlike most other integrated packages, FormManager's data management is not limited by memory size. It can handle up to 32,767 records, 10 forms per record, 100 fields per form and 80 characters per field. Its state-of-the-art B-tree technique assures you fast sorting and searching even if your data grows. There are several ways to search for a record randomly or sequentially.

### Macro and Math features simplify data processing.

FormManager's built-in math capability provides 26 general math functions beyond the usual four arithmetic functions. You can define multiple formulas for interactive calculation (as in your spreadsheet programs). Its macro facility in-

cludes repetitive (\$DO) and conditional (\$IF) statements. You can easily set up a task such as:

IF state = "CA" then TAX = sub\_total \* 0.065.

The screenshot shows the FormManager application window. At the top, there's a title bar 'FormManager' and a menu bar with 'File', 'Edit', 'Form', 'Data', 'Help'. Below the menu bar, there's a 'Form Entry' section with fields for 'Name', 'Street', 'City', 'State', 'Zip', and 'Phone'. The 'City' field is set to 'San Jose'. Below this is a table with 5 columns: 'Item', 'Description', 'Qty', 'Price', and 'Total'. The table has 6 rows. The first row is empty. The second row has '100' in the 'Qty' column and '5' in the 'Price' column. The third row has '100' in the 'Qty' column and '5' in the 'Price' column. The fourth row has '100' in the 'Qty' column and '5' in the 'Price' column. The fifth row has '100' in the 'Qty' column and '5' in the 'Price' column. The sixth row has '100' in the 'Qty' column and '5' in the 'Price' column. At the bottom of the window, there's a status bar with 'Date: 01/01/84', 'Page: 1 of 1', and 'Record: 1'.

### Printing, of course.

Print functions allow you to print from the screen to your pre-printed paper form. Or you can select to print any number of fields from all your records.

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# The Pascal/MT+86 System

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## Pascal/MT+86 Version 3.1

Speed Programming Package (SPP-86)  
Version 3.0

Digital Research Incorporated  
P.O. Box 579  
Pacific Grove, CA 93950  
(408) 649-3896

**List Price:** Pascal/MT+86, \$600; SPP-86, \$250; both, \$800.

**Requires:** 192K RAM, 2 disk drives preferred.

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With the Pascal/MT+86 system, Digital Research Inc.'s language division has put together all the tools needed by the Pascal programmer. A special Pascal screen editor, compiler, linker, assembler, debugger, disassembler, and a software librarian are included in the package. The

only item not included in the price is the Pascal screen editor, a program that includes a syntax checker, variable identifier, text reformatter, and a backup/logger utility. I cannot think of much more a programmer would want. The \$800 price for the language and the screen editor might seem a bit steep, until you look at what you are getting: a quality package from a quality company you can rely on for support. This support is especially important for the independent software vendors creating all the new application packages everyone seems to be buying. An added advantage of DRI's Pascal is the portability of the source code. With few exceptions, you can take the source code developed on a CP/M-86 system and sell it for a PC-DOS system. Digital Research is even talking about creating a UNIX version of its Pascal and other languages, which would further increase the software vendors'

market. The beauty of the Pascal language, combined with the many programming tools available, and the large marketplace make the DRI package an irresistible development tool for software vendors.

Digital Research's Pascal is a full implementation of the ISO standard Pascal (ISO standard DPS/7185) with some powerful (and necessary) additions. There are four areas of additions: enhanced I/O capabilities, additional data types, access to the run-time system (access to CP/M and PC-DOS), and modules and overlays. The additions will be mentioned again as each language ingredient is examined.

## Constants, Variables, and Data Types

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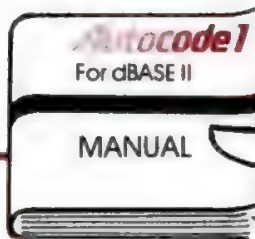


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the first eight characters. The identifier can be any combination of letters, numbers, and underscores (.), as long as it starts with a letter. Both numeric and string literals can be used as constants. Unlike some versions of Pascal, this version allows the null string to be used. There are two kinds of data types that can be defined: simple and structured. Characters, integers, long integers, real, byte, word, pointers, and Boolean are examples of simple types. Another important simple type is the user-defined ordinal type, of which there are two kinds: enumerated and subrange. The enumerated ordinal type is used to define a special data type, and lists all the possible values that type can have. The subrange type is used to select a range of values from a previously defined ordinal set. Examples of both types are shown in Figure 1.

The structured data type includes arrays, records, sets, strings, and files. The record types can be quite complex. They can include a CASE statement that changes the structure of the record, depending on the value of a special case selector variable.

### Operators and Expressions

The large group of operators that used to construct the different expressions in Pascal/MT+86 are listed in Figure 2. There are operators for addition, subtraction, division, and multiplication. A function must be used for exponentiation. For integer division, Div and Mod operators result in the integer quotient and remainder, respectively. Boolean operators in expressions result in values of True or False. Boolean operators in relational expressions can use many types of operands, but always produce a Boolean result. There are also special Boolean

operators that work only with Boolean operands. The logical operators work with individual bits in words and bytes. The last group of operators work with sets and allow you to compare different sets for equality, inequality, and subset status. Unions, intersections, and set assignments are also possible.

### Statements

There are eight major statements in the Pascal/MT+86 language. The first is the simple assignment statement, which sets a variable or literal to a certain value. The CASE statement executes different groups of statements, depending on whether the case variable matches one of the enumerated case values. Pascal/MT+86 has added an ELSE to the CASE statement so that if the case variable does not match any of the choices, you can still direct program flow. If you do not use the ELSE and there is no match, control falls to the next statement below CASE. FOR allows program loops using either the form FOR  $x := \text{low}$  TO high DO or FOR  $x := \text{high}$  DOWNTOW low DO. The GOTO statement allows you to transfer program control to a labeled statement. The IF-THEN-ELSE statements can be nested many layers deep to provide a very structured decision tree. Two statements allow for continual execution of a group of statements until an exit condition is met. The REPEAT command executes the statements and then checks the exit condition so that it always executes at least once. The WHILE command checks the controlling condition first, and then executes the statements if the controlling condition is TRUE. The last statement, WITH, makes it very easy to access a record's subfields in a group of statements without having to use the full record `_name.field_name` format.

### Procedures and Functions

The many different procedures and functions already supplied with Pascal/MT+86, in addition to the ones you write are the basic units of any Pascal program. Each procedure starts with the name of the procedure, the variables and their types, which are passed to the procedure, and the procedure type. Each function is defined similarly. Pascal/MT+86 supports functions and procedures that are separately and mutually recursive. An interrupt procedure is also included in the package. A list of the different procedures and functions is given in Figure 3.

A number of procedures have been added that are not in the ISO standard: bit manipulations, I/O port setting and checking, redirectable user I/O routines, fast file I/O, random file access, string manipulations, heap memory management, function addresses and sizes, and move and fill features. Several of the procedures and functions deserve special note. The IN-LINE procedure allows you to insert an assembly language command right in the middle of your Pascal source program.

**A**LL PASCAL  
programs must be  
structured the same  
way.

Special error handling is controlled by the @ERR procedure. The @BDOS86 function allows interfacing to the computer's operating system. The MAXAVAIL and MEMAVAIL functions return the largest memory block available and available memory, respectively (regardless of fragmentation) for program control of the memory structure. There are also many procedures and functions to handle string manipulations, trigonometric calculations, odd and even number detection, file and peripheral I/O, and bit testing and setting.

All Pascal programs must be structured the same way. The program name is first, followed by the different data type definitions. All literal, constant, and variable definitions are then listed. Any external

Figure 1: An example of the enumerated and subrange ordinal types.

```
TYPE STUDENTS = (FRESHMEN, SOPHOMORE, JUNIOR, SENIOR);
      NAMES    = (MARGENE, GEORGE, FRANCES, JACK, LINDA);
      PETS      = (DOG, CAT, BIRD, FISH, TARANTULA);
```

#### Enumerated Ordinal Type

```
TYPE NUMBERS = '0'.. '9';
      INDEX   = 1.. 25;
      GOOD_PET = DOG.. FISH;
```

#### Subrange Ordinal Type



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procedures or functions are listed next, followed by program procedures and functions. The main program section, which calls the different procedures, is

**T**HERE are various ways to move information back and forth from the program to files and peripheral devices.

the last item.

DRI has added some powerful options to its Pascal. The programmer can create several modules of procedures and functions and compile and file them separately, or keep them in a module library for linking to other compile routines later. This modular strategy produces programs that are easy to maintain and test. In a case where insufficient RAM is available for a large program, Pascal/MT+86 allows for program overlays so that each section can be brought off from the disk as needed.

To use overlays, you create one main root program, and up to 255 overlays. Overlays can call other overlays, can access procedures and functions in the root program, and may contain an arbitrary number of modules. The programmer has complete control of the overlay memory usage and location. A warning however: This capability adds responsibility and danger to the programmer's chores.

Another nice option is the ability to chain to other programs from the starting program. Procedures and modules written in assembly language for those operations where execution time is very critical can also be used.

### Input/Output

There are various ways to move information back and forth from the program to files and peripheral devices. The standard procedures and functions of Pascal/MT+86 allow two different kinds of file I/O: sequential and random. With the ability to redirect the data with user-defined

Figure 2: A summary of Pascal/MT+ 86 operators.

Operator	Operation	Operands	Result	Precedence
Arithmetic				
+	unary identity	integer or real	same as operand	3rd highest
+	addition,	integer, real or pointer	same as operand	3rd highest
-	unary sign inversion	integer or real	same as operand	3rd highest
-	subtraction,	integer or real	same as operand	3rd highest
*	multiplication	integer or real	integer	2nd highest
div	integer division	integer	integer	2nd highest
/	real division	integer or real	real	2nd highest
mod	modulus	integer	integer	2nd highest

Operator	Operation	Operand	Result	Precedence
Relational				
=	equality	scalar, string set, pointer record	boolean	lowest
< >	inequality	scalar, string set, pointer record	boolean	lowest
<	less than	scalar or string	boolean	lowest
>	greater than	string	boolean	lowest
< =	less or equal	scalar or string	boolean	lowest
> =	or set inclusion greater or equal	set scalar or string	boolean	lowest
IN	or set inclusion set membership	(see 4.4) (see 4.4)	boolean	lowest
Boolean				
NOT	negation	boolean	boolean	highest
OR	disjunction	boolean	boolean	3rd highest
AND	conjunction	boolean	boolean	2nd highest
Logical				
~ ?	one's complement of operand	integers and pointers	same as operand	highest
or /	logical OR	integers and pointers	same as operand	3rd highest
! or	logical AND	integers and pointers	same as operand	2nd highest
Set				
+	union	set	set	3rd highest
-	set difference	set	set	3rd highest
*	intersection	set	set	3rd highest



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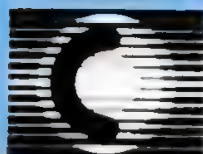
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I/O routines, the programmer can create his own type of file storage. The record data type should lead to routines that create ISAM or keyed files without too much difficulty. The port functions allow programs to control devices tied to certain port channels (physical devices) depending on the activity on other port channels. When reading or writing to files, there is a file variable that contains two parts: a File Information Block (FIB) and a buffer. The FIB contains the file's name and type, whether the file is open for reading or writing, and the end-of-file and end-of-line flags. The buffer contains one data item at a time. You write and read from this buffer only; DRI calls it the window variable. The manual contains several helpful examples of different types of file, keyboard, screen, and printer I/O routines.

### SPP-86 Speed Programming Package

Now that we are familiar with Digital Research's Pascal, let's look at how to create, run, and debug programs. If you spend \$600 to buy the Pascal/MT+86, you might as well go ahead and spend an additional \$200 to buy the SPP-86 screen editor.

Although you can create Pascal source code using a word processor, the word processor does not contain a syntax checker, variable identifier checker, a Pascal

## I LOATHE control and escape sequences, but these are not too bad.

text reformatter, or a backup/logger utility. I found these tools to be extremely helpful in creating and editing Pascal programs. The full screen editor allows easy creation and updating of programs. There are 26 different commands, which are activated by pressing the Ctrl key and another key (A through Z) simultaneously. I personally loathe control and escape sequences, but these are not too bad.

Once you have created a Pascal pro-

gram or updated one using the editor, you can use the syntax checker to make a single pass through your program to check for misplaced or missing semicolons or missing arguments from statements. When the syntax checker finds a mistake, it stops, places you in the screen editor, and displays the program and a message indicating where the mistake is (or close to it). The Varcheck variable identifier checker scans the program and generates a list of identifiers that are possibly misspelled or undefined. After you have fixed any syntax and identifier errors, you can call the reformatter to beautify your program. It indents all nested statements, producing a more readable source listing. The last utility provided by SPP-86 is an automatic backup/logger utility, which creates a backup file of your source every time you enter the editor and change the original. The utility will also increment a version number contained in parenthesis located at the beginning of the program.

### Compiling and Linking

The next step after creating a program is to compile the Pascal program and assemble (using the ASMT-86 relocatable assembler) any assembly modules. The relocatable object files should have a file name: file\_name.R86. The compiler has several options that allow you to choose which disks different files can be found on, or which disk to put them on. The options include: suppress unnecessary console messages; generate debugger information; generate disassembler information; and continue on error.

You should now have two relocatable object files. The next step is to link the Pascal object code and the assembler object code with any run-time library routines and overlays that are needed by the Pascal program. Only the routines needed by the program are taken from the library and linked. The linker command also has some options that control the amount of memory and locations assigned to the code and data sections of the program and overlays. You can also determine how the linker output will look. After linking, you should have a runnable program that has a file name like this: file\_name.CMD.

### Software Librarian

The LIB/MT+86 librarian lets you create different general purpose modules and store them together in special libraries

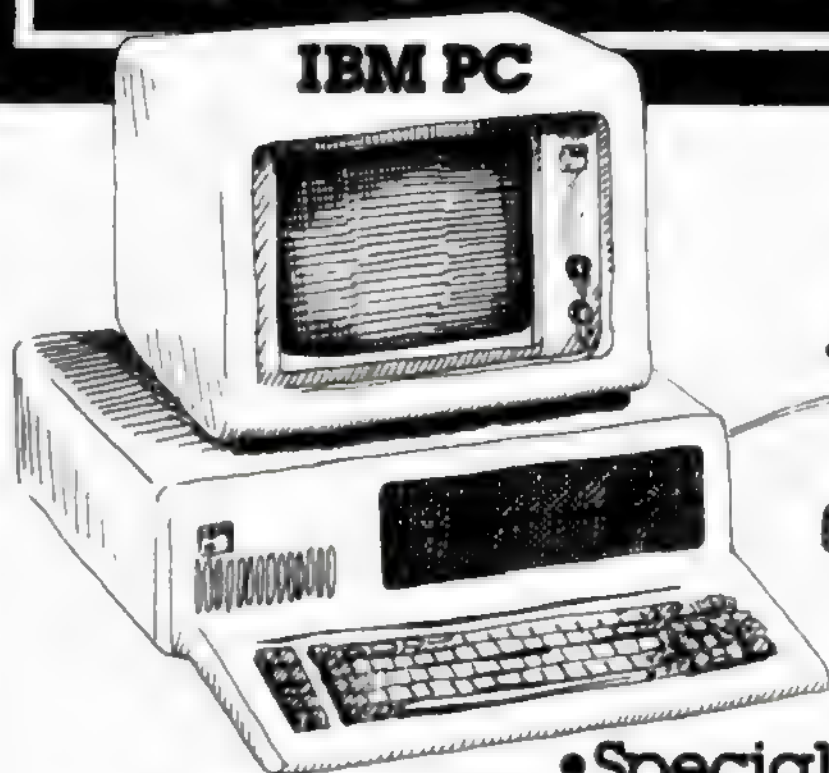
Figure 3: A list of the functions and procedures included in the Pascal package.

FUNCTIONS			
@BDOS	@BDOS86	@CMD	@HERR
@MRK	@RLS	ABS	ADDR
ARCTAN	CHR	CONCAT	COPY
COS	EOF	EOLN	EXP
GNB	HI	IORESUL	LENGTH
LN	LO	MAXAVAIL	MEMAVAIL
ODD	ORD	POS	PRED
RIM85	ROUND	SHL	SHR
SIN	SIZEOF	SQR	SQRT
SUCC	SWAP	TRUNC	TSTBIT
WNB			
PROCEDURES			
@ERR	@HLT	ASSIGN	CHAIN
CLOSE	CLOSEDEL	CLRBIT	DELETE
DISPOSE	EXIT	FILLCHAR	GET
INLINE	INSERT	LWRITEHEX	MOVE
MOVELEFT	MOVERIGHT	NEW	OPEN
PACK	PAGE	PURGE	PUT
READ	READHEX	READLN	RESET
REWRITE	RIM85	SEEKREAD	SEEKWRITE
SETBIT	UNPACK	WAIT	WRITE
WRITEHEX	Writeln		

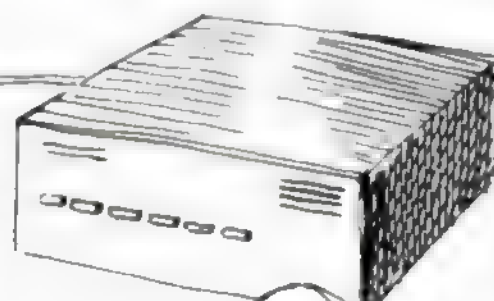


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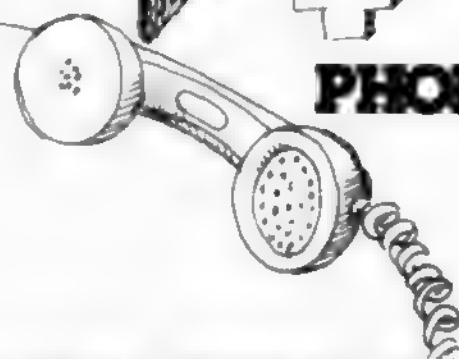
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that can later link to other main programs. You might, for example, want to create several printer I/O routines or RS-232 modules, which can be used over and over again by many programs. The compiled modules must be relocatable object code files to be entered into a library. You can concatenate other libraries, assembly modules, and Pascal modules into one library.

### Debugging and Disassembling

The debugger is included to help find any logic mistakes that might be present in your routines. There are several helpful features of the debugger that aid in testing the software. The debugger can do the following: display variables in many formats; modify memory; set regular or symbolic breakpoints; single-step through the program; display symbol tables; and display entry and exit points for procedures

and functions.

To use the debugger, a special flag must be set in the compiler when compiling the program to be debugged. The linker command parameters are also different when linking a program to be debugged. The disassembler is useful for a programmer wanting to see how a Pascal program was converted into the 8086 assembler language. Both the disassembled assembly language instructions and the Pascal statements are shown in blocks so that the programmer can follow the logic of each section.

### Manual

The Pascal manual comes in the now-familiar tan enclosures similar to the ones in which IBM distributes its software. The documentation is divided into three sections: the Language Reference Manual, the Language Programmer's Guide, and the

ASMT+86 Relocating Assembler Reference Manual. The first section gives a brief overview of how Pascal is structured and the features of DRI's Pascal. It explains any differences between this version and the ISO version. Most of the section is taken up with a description of all the functions and procedures provided with Pascal/MT+86. All the data types and statements are described and many include examples. The last chapter in the first section gives a good explanation of the different types of input and output available.

The second section gives detailed instructions about how to compile, link, debug, disassemble, create libraries, and also includes other important facts a programmer needs to know. This section explains error messages and describes how to create overlays and modules, how to chain programs together, how to interface with assembly language routines, how to interface with the operating system, how to create ROM-based programs. The last section explains how to use the relocating assembler and what different conventions it will accept.

Overall, the manual has a professional appearance. DRI uses different colors to emphasize points and list examples. The table of contents and index are detailed for easy reference. I have only two comments about the manual. It could have included more examples, especially with some of the function and procedure descriptions. And, the beginning programmer would probably find the manual too technical. Of course, DRI's main customer is not the beginning programmer, but the independent software vendor. I found the same faults in DRI's Concurrent CP/M-86 manual. The company's PL/I manual, however, is much better.

I found that both the Pascal/MT+86 and the SPP-86 worked well, and that any major problems with the system were the result of my own errors. The SPP-86 works nicely in creating Pascal source. The rest of the programming tools (compiler, linker, disassembler, debugger, and librarian) all worked as described in the manual.

With such a large following just beginning for Pascal, DRI should find its package being used more and more in vendors' software. With the tools there to create powerful, versatile modular programs, the Pascal/MT+86 and SPP-86 team is hard to beat. DRI has again provided a professional, complete package.

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## SPP-86 Function Key Programming

*An alternative to using the control sequence commands with the screen editor.*

With the SPP-86 Pascal Speed Programming Package, an understanding of 26 different Ctrl/letter sequences is required to use the screen editor. Even though these control sequence commands can be mastered with practice, I came up with an easier way. Although the manual does not mention it, you can use CP/M's function command or one of the many PC-DOS function key utilities to set up the ten most commonly used editor commands. For instance, in the screen editor configuration, you cannot use the arrow keys, home, delete, etc., but using the function key utilities enables you to set up those special keys to produce the needed control sequences.

I set up the different direction keys to work with SPP-86's screen editor to produce a much easier working environment.

Function key F1 ;SDIR\0D\00  
Function key F2 <SDIR\00  
Function key F3 =STAT \*. \*\0D\00  
Function key F4 >STAT\00  
Function key F5 ?VCMODE D\0D\00  
Function key F6 @VCMODE B\0D\00  
Function key F7 ADSKMAINT\0D\00

Function key F8 BFUNCTION\00  
Function key F9 CHELP\0D\00  
Function key F10 DDSKRESET  
\0D\00  
G\14\00 home key  
H\0B\00 up arrow  
I\03\00 page up  
K\08\00 left arrow  
M\0C\00 right arrow  
O\02\00 end key  
P\0A\00 down arrow  
Q\12\00 page down  
R\06\00 ins key  
S\19\00 del key

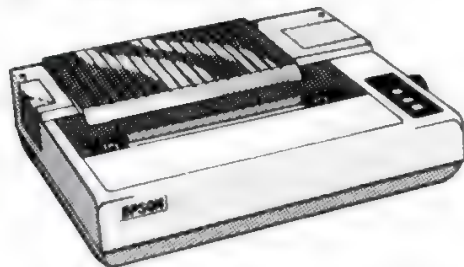
I did not use the regular ten function keys for the SPP-86 commands, although they could have been used, if desired. Then 20 out of the 26 control sequence commands would be reduced to a single keystroke. The \0D is a carriage return (in hex) and "\00" is the hex character telling the function utility where the end of the definition is. This same function key arrangement can be implemented in Concurrent CP/M-86 using the same Function command. If you have PC-DOS, you will either have to buy a function key handler utility, or find one in the free software domain.—G.D.H.





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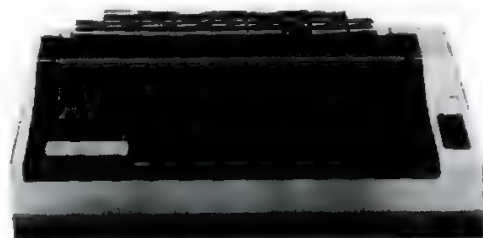
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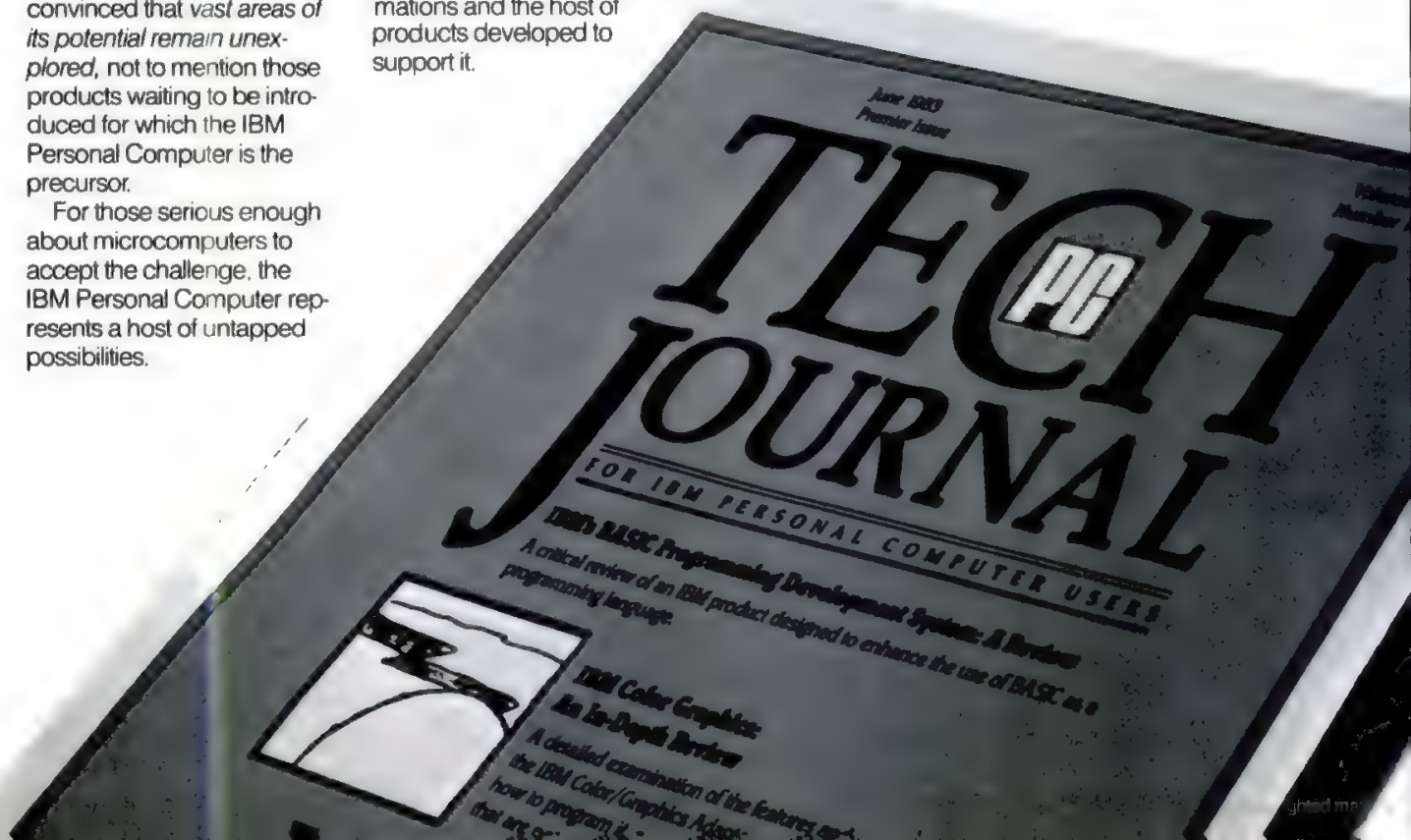
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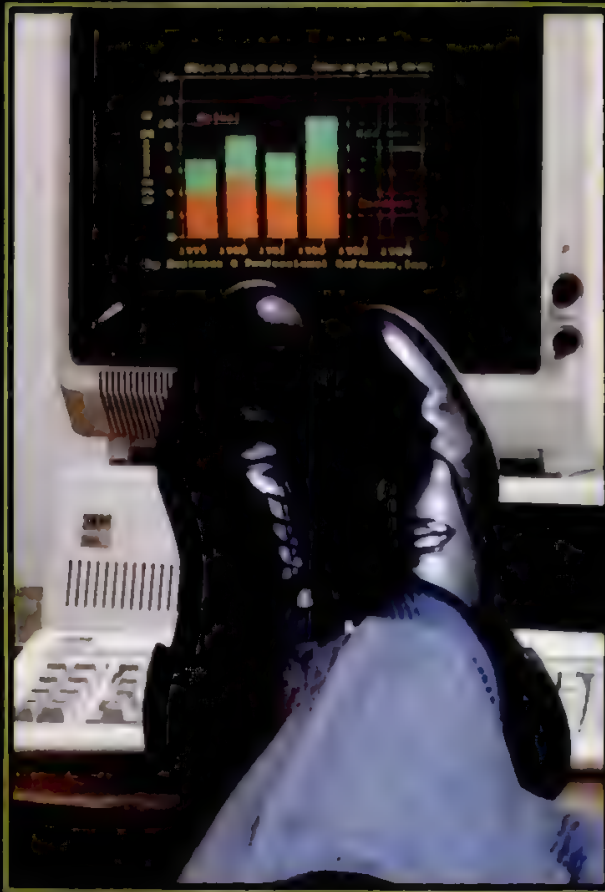
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*Linkers can span operating systems, mix programming languages, conserve memory, and more—putting an end to your programming gripes.*

# The Missing Linker

There you are, joyfully banging out lines of BASIC, when your arms fall to your sides and an eerie sense of ill-being comes over you. The lines you just typed look strangely familiar.

```
510 IF ERR=70 then print
    "disk is write protec-
    ted"
520 IF ERR=71 then print
    "drive error"
530 IF ERR=72 then print
    "disk error"
```

Somewhere, you have written these lines before. Yes, it was in version 7 of your checkbook program, the one you did last week! Since you hate to type, you pull out your copy of CHKBK07.BAS, and copy 45 lines of the program into your new opus. Patting yourself on the back with your left hand, you save the new program with your right, only to be informed by DOS that you are out of disk space: Go directly to jail, do not pass go, do not collect \$200. This revolting development causes you to enter a long period of reflection about the state of the world, leading to some weighty philosophical questions.

- Why can't there be just one copy of each of the routines that you use all the time—the ones to clear the screen, check for errors, draw nice boxes on the screen—instead of having to include the routines in every program that needs them and thereby run out of disk space?

- Why can't you give each routine a name and refer to it just by that name? Then every time you wanted your program to draw a box you could just write BOX, and the program would find the routine called box and use it. You can do that in Pascal and C. Why not in BASIC?

- You have been led to believe that BASIC, Pascal, COBOL, FORTRAN, and C compilers produce code for the 8086/8088. If all these languages boil down to the same thing in the end, then why can't you use BASIC routines when you're writing in Pascal, or FORTRAN routines when you're writing in COBOL?

- And what if you want to switch from PC-DOS to CP/M-86 or vice versa? Why should you have to rewrite all the routines you used under the other operating system? It's the same PC, after all.

● One last gripe. You'd love to use the RAM disk that eats up 256K of your computer's memory, but you only have another 64K, and all your programs need at least 128K after they're compiled. Isn't there some way to make the programs require less memory so that you can use your RAM disk without trading in your Sunday clothes for another 256K?

## A LINKAGE editor is a program that performs a function similar to that of an assembly-line robot.

Relief is here with a program called LINK, which comes with PC-DOS. This program, and programs like it, are called "linkage editors." A linkage editor is a program that performs a function similar to that of an assembly-line robot, pulling the right parts out of the appropriate bins, and assembling them according to the instructions given. Let's consider our questions and complaints one by one, and see how a linkage editor can help.

### The Copy Problem

Suppose you compile the following Pascal program, and get an OBJ file called HELLO.OBJ.

```
module hi;
```

```
procedure hello;
begin writeln('Hello') end;
end.
```

Sometime later, you write a program called GLADHAND.

```
program gladhand;
procedure hello; external;
begin hello hello hello hello
end.
```

When this is compiled into GLADHAND.OBJ, you are ready to use the linkage editor. If you type:

```
LINK gladhand hello;
```

the linkage editor will search through GLADHAND.OBJ, and note that there are four references to the routine called HELLO. For the first reference, it will copy the code from HELLO.OBJ into GLADHAND.EXE. For all the other references, it will simply call this code rather than insert a redundant copy.

There are still two copies of the routine HELLO: one in HELLO.OBJ, and one in GLADHAND.OBJ. But there is one important difference: HELLO is compiled only once, and forever after, the compiled copy is transferred into programs that need it, rather than having to be recompiled each time. This technique is faster. If you've ever waited for a compiler to finish, you'll appreciate the improvement.

### The Naming Problem

The example above shows how a named routine in Pascal can be linked. The same can be done in BASIC by keeping each routine in a separate OBJ file, which can get unwieldy if you have a few hundred BASIC routines that you use

often, each in a separate file.

To avoid this problem of OBJ file proliferation, linkage editors can also combine code into LIB, or library, files. A LIB file is created by combining OBJ files; one library may be created from hundreds of separate OBJ files. There is a special utility to do this combining, which is appropriately called a "library manager." Combining the OBJ files with a library manager allows you to put all your routines into a single file.

The library manager also allows you to edit libraries; you can extract, replace, or delete any routine in a library. Some library managers (PLIB-86, from Phoenix Software Associates, for example) will also generate lists of what routines are in the library, what other library routines they use, and all symbols defined in the library. This feature is very useful in dissecting libraries that have no source code.

FORTRAN.LIB, COBLIB.LIB, BASLIB.LIB, and PASCAL.LIB are collections of routines that do all the common tasks a program might require. The compiler translates source language statements into references to the library routines, and the linker then copies in those library routines that have been referenced. This is why LINK is included with PC-DOS. Without it, you would not be able to use any of the language compilers.

**T**HE LINKER doesn't care if the pieces were originally written in Pascal, BASIC, C, FORTRAN, or assembler; it will combine them all together.

### The Language Problem

Since the linkage editor links OBJ files, it doesn't matter how those OBJ files were produced. (Some exceptions will be discussed later.) The linker doesn't care if the

After the compiler turns a program into object code, it is combined with library routines to become a complete, executable program.

```

Source code >>> Compiler >> Object file(s) (OBJ) >>> Linker >> EXE

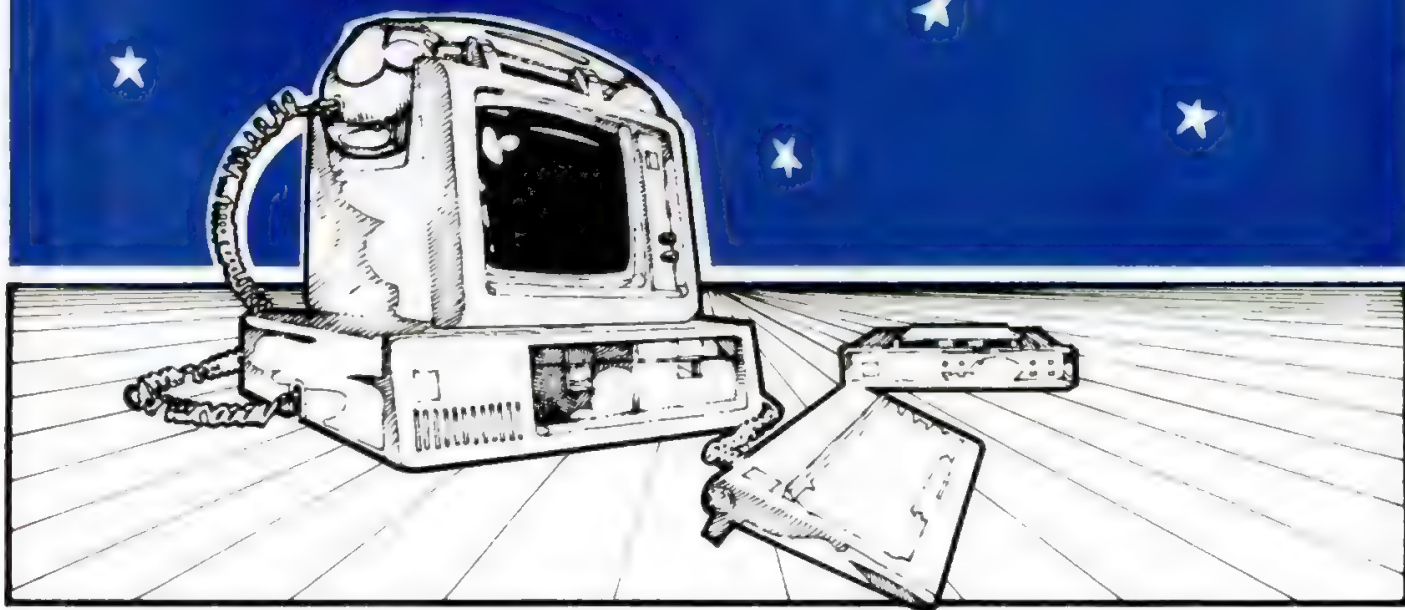
                                Library(s)
                                BASLIB.LIB
                                v
MYPROG.BAS >> BASCOM >> MYPROG.OBJ >>>> LINK >> MYPROG.EXE
                                OBJ file  OBJ file  OBJ file
```

library manager

library file  
(LIB)



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IBM Personal Computer with 128k, at least one diskette drive, 80 column monochrome or color monitor, and a Hayes Smartmodem or Novation Smart-Cat. Printer is recommended.

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pieces were originally written in Pascal, BASIC, C, FORTRAN, or assembler; it will combine them all together. This fact has some interesting implications.

## **T**HE LINKER makes it possible to write sections of your programs in different languages.

Although it is certainly possible to do anything in any programming language, you may not always be able to do it as quickly or simply as you could if you used the "appropriate" language. If speed of execution is critical, you would probably want to use assembly language. BASIC lends itself to intensive debugging with the interpreter. Pascal is appropriate for very large programs.

The linker makes it possible to write sections of a program in different languages. You may, for example, have to do extensive number crunching in a large program, for which you need the speed of assembly language. But it would be time consuming to write the whole program in assembly language. The solution is to write the math routines in assembler and the rest of the program in Pascal, and link them together. Many commercial programs contain sections of time-critical code, which were written in assembly language, while the bulk of the programs were done in a higher level language.

Suppose you had a program consisting of three parts—a part written in FORTRAN (fpart), a part written in Pascal (ppart), and a part written in assembly language (apart). After compiling each part with the appropriate language compiler, and getting three OBJ files, you could use LINK to put them together like this:

```
link fpart ppart apart,  
    program, .fortran.lib  
    pascal.lib
```

You are giving LINK three instructions: Combine fpart, ppart, and apart into a program called "program"; refrain from generating a listing file (indicated by the two

commas with nothing between them); and, if there are routines that are not defined in any of the three OBJ files, look for them in the files FORTRAN.LIB and PASCAL.LIB.

You must be aware of one thing before you try to link different languages together: Their data must be represented in the

same way, if the languages are to share it. Microsoft/IBM Pascal and FORTRAN, for example, use a common definition for most types of data, but there is nothing corresponding to the Pascal STRING in FORTRAN, and nothing corresponding to the FORTRAN INTEGER\*4 in Pascal. Either these incompatible types of data

## Product Information (And Explanation)

*A summary of the linkers and librarians mentioned in the article.*

### PC-DOS

IBM Corporation  
Systems Product Division  
P.O. Box 1328  
Boca Raton, FL 33432  
(305) 998-2000

List Price: \$40

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LINK runs under PC-DOS or MS-DOS, and is included with the operating system. LINK connects OBJ files generated by any of the Microsoft or IBM compilers, producing EXE files. The Microsoft OBJ format is a slight modification of Intel's original OBJ format, made to speed library searches. Thus, LINK cannot handle all Intel or CP/M-86 compilers' output files. LINK does not generate overlays.

### LINK-86

Digital Research, Inc.  
160 Central Ave.  
Pacific Grove, CA 93950  
(408) 649-3896

List Price: \$250

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LINK-86, is included with all Digital Research language compilers, or is available separately, with LIB and a relocating assembler. Functionally, it is the same as the LINK-80 for CP/M-80. LINK-86 runs under CP/M-86, and was recently announced to run under PC-DOS. It links Intel-format OBJ files produced by the Digital Research language compilers (CBASIC-86, Pascal MT/86, PL-1/86, and

COBOL), and the related tools (access manager, display manager). The CP/M-86 version produces CMD files, which run under CP/M-86, and the PC-DOS version produces EXE files, which run under PC-DOS. It will link some, but not all, Microsoft or IBM OBJ files, and it supports overlays. The library manager LIB is included with LINK-86.

PLINK-86, (available to run under PC-DOS or CP/M-86)

Phoenix Software Associates  
P.O. Box 207  
North Easton, MA  
(617) 238-0168

CIRCLE 691 ON READER SERVICE CARD

Lifeboat Associates  
1651 Third Ave.  
New York, NY 10028  
(212) 860-0300

List Price: \$350 each, or \$500 for both.

CIRCLE 690 ON READER SERVICE CARD

PLINK-86 comes in two versions, one that runs under PC-DOS and one that runs under CP/M-86. In either case, the program helps bridge the gap between the two operating systems. Both versions link Microsoft-format OBJ files to produce both "EXE" files for PC- MS-DOS, and CMD files for CP/M-86. Both handle overlays. There is support for PC- MS-DOS 2.0 path names, as well as an extensive set of diagnostic and reporting facilities. In addition, this linker is significantly faster than LINK, includes a library manager and cross-reference facility, and provides better documentation than LINK or LINK-86.  
—M.O.





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Figure 1: In overlaying, one block of memory is shared by two or more parts of the program.

	Contents of memory	On Disk
When music is being played	Part two Part one	Part three
When characters are printed	Part three Part one	Part two

must not be shared, or the program pieces must be written to account for the incompatibilities.

## **L**INKERS *make it possible to shift between languages and operating systems without starting from scratch.*

Individuals and large organizations are the same in one respect: Once they devote time and money to writing and debugging software, they don't like to throw it away and start over. Linkers make it possible to shift between languages and operating systems without starting from scratch. Large FORTRAN programs on mainframe

computers can be linked with Pascal programs. And, if you decide that you'd like to switch to programming in C, there's no need to rewrite all of your finely crafted assembly language routines; just link them in.

### Extending the Language

You want to add a new command to your BASIC? Okay, just write the routine and add it to BASLIB.LIB. Then you can use it in your program as if it were a built-in BASIC command. The linker will copy the code from BASLIB.LIB when the program is compiled.

Although it can be tricky, you may also replace any of the routines in BASLIB.LIB with your own routines. You must be sure, however, that your routine does exactly what the original one did, and that it leaves the environment exactly the same. It is through this method that some companies have added 8087 arithmetic chip support to standard Microsoft BASIC and Pascal; they replace the software math

routines in BASLIB.LIB and PASCAL.LIB with routines that use the hardware math capabilities of the 8087.

The same set of routines can, with the right linker, be used in either CP/M-86 programs or PC-DOS programs, with no modification.

This convenience is largely due to the influence of Intel as the manufacturer of the 8086/8088. When the chip was first released, Intel defined an OBJ format for its compilers, which was taken as a model by both Microsoft and Digital Research. Digital Research adopted the Intel OBJ format in its entirety.

## **A**S NEW *operating systems like VisiOn, Xenix, and Pick move onto the PC, linkers will move with them.*

However, Microsoft made some minor changes to the Intel OBJ format to speed library searches. Provided a library doesn't have to be searched, the Digital Research/Intel and the Microsoft/IBM formats are compatible. Unfortunately, any language, except assembly language, will require that a library be searched! This

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- The OBJ files produced by the Microsoft/IBM languages (except for MASM) may not be linked with the OBJ files produced by the Digital Research languages. This is true whether the Digital Research languages are running under CP/M-86 or PC-DOS.

### Bridging the Gaps

There is a linker that will partly bridge this operating system gap. *PLINK-86* from Phoenix Software Associates will allow you to generate, from any Microsoft/IBM format OBJ files, both a CMD file for CP/M-86 and an EXE file for PS-DOS. It does not solve the problem of the incompatible

OBJ formats (at least not in the current version), since it cannot handle the OBJ output of the Digital Research compilers, but it does allow you to span operating systems without changing your routines.

A linkage editor can even help you reduce the amount of memory required for your programs to run. This can give you plenty of extra memory for RAM disks, print spoolers, or other uses.

The method used for saving memory is known as overlaying, a feature not found in IBM/Microsoft LINK, but available in the Digital Research and Phoenix products. If you use WordStar or dBase II, you are already familiar with program overlaying, which both of these popular products use to conserve memory.

Overlaying is the sharing of one block of memory by two or more parts of a program. Suppose you have a program with three parts (see Figure 1). Part one gets characters from the keyboard. Part two plays the characters as music. Part three puts them on the screen. Part three and part two both need part one to get the char-

acters for them, so part one always has to be in memory. But part three is independent of part two, and vice versa. Both don't have to be in memory at the same time. You could put part two in memory, and, when the task it was performing was completed, replace it with part three. When part three was done, you could replace it with part two, and so forth.

**I**F YOU USE  
only the BASIC  
interpreter, you are  
unlikely to ever need a  
linker.

An overlaying linker generates a program that will keep track of which parts of itself are in which parts of memory, and automatically replace those parts that are not needed, filling the vacated space with parts of the program that are needed. This allows very large programs to run in limited memory space. Programs as large as 2 megabytes can run on a computer with only 48K RAM. (Of course, the swapping slows things down, but not appreciably on a hard disk.) Some very large programs, which otherwise would not fit on your PC, can fit very easily with overlaying. Others that would fit can be overlayed in order to free memory for other uses.

With so many advantages, is there any reason not to use a linker? Certainly, if you use only the BASIC interpreter, you are unlikely to ever need a linker. But anyone who uses a compiler, wishes to build a program in a modular fashion, wants to mix programming languages, span operating systems, or conserve memory, will find linkers and librarians indispensable. And as new operating systems like VisiOn, Xenix, and Pick move onto the PC, linkers will move with them, so that you will never again have to write:

```
510 IF ERR=70 then print
    "disk is write protec-
    ted"
520 IF ERR=71 then print
    "drive error"
530 IF ERR=72 then print
    "disk error" /PC
```

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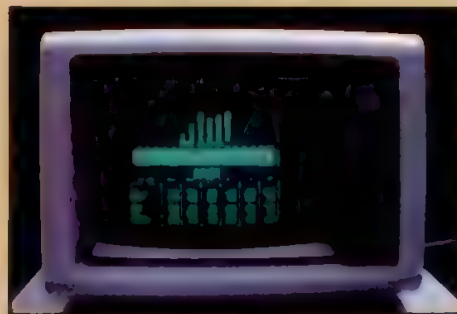
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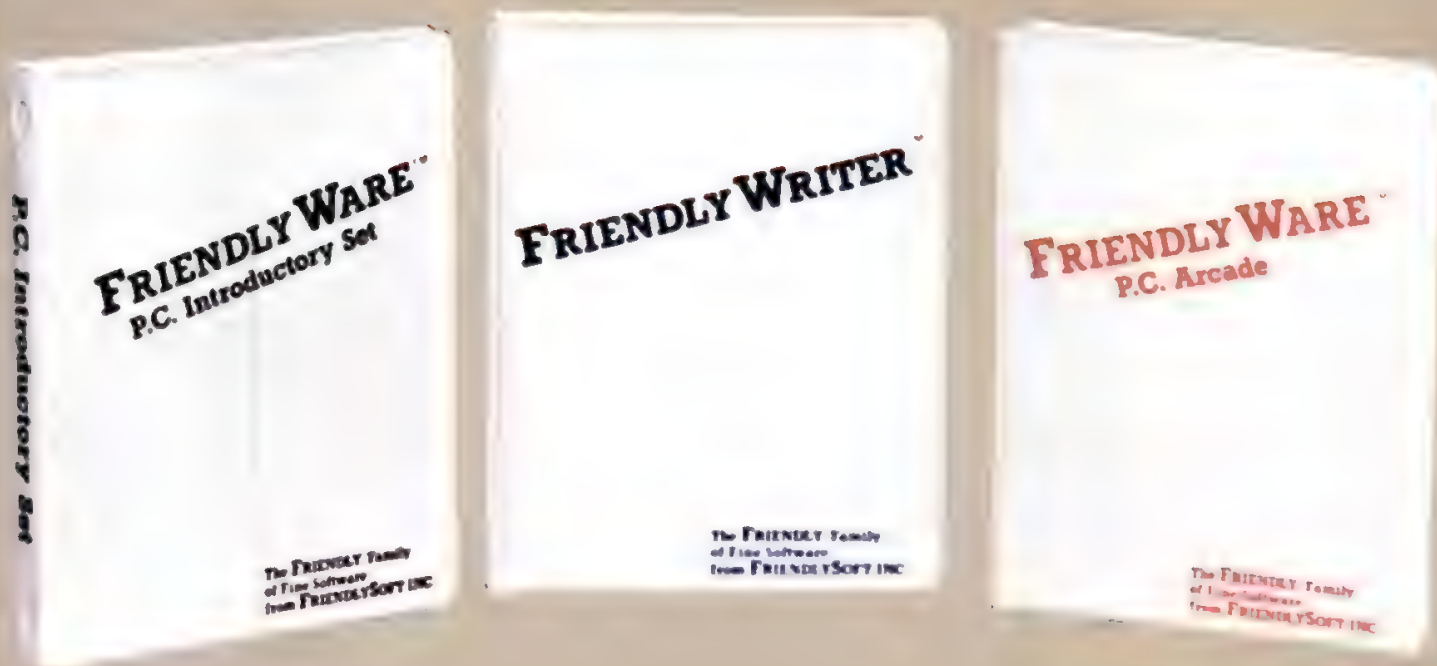
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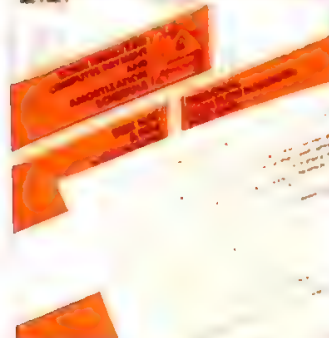
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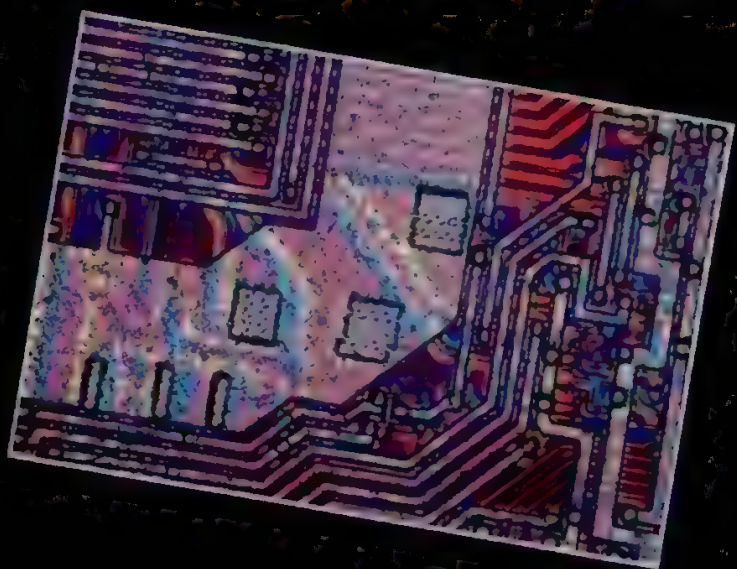




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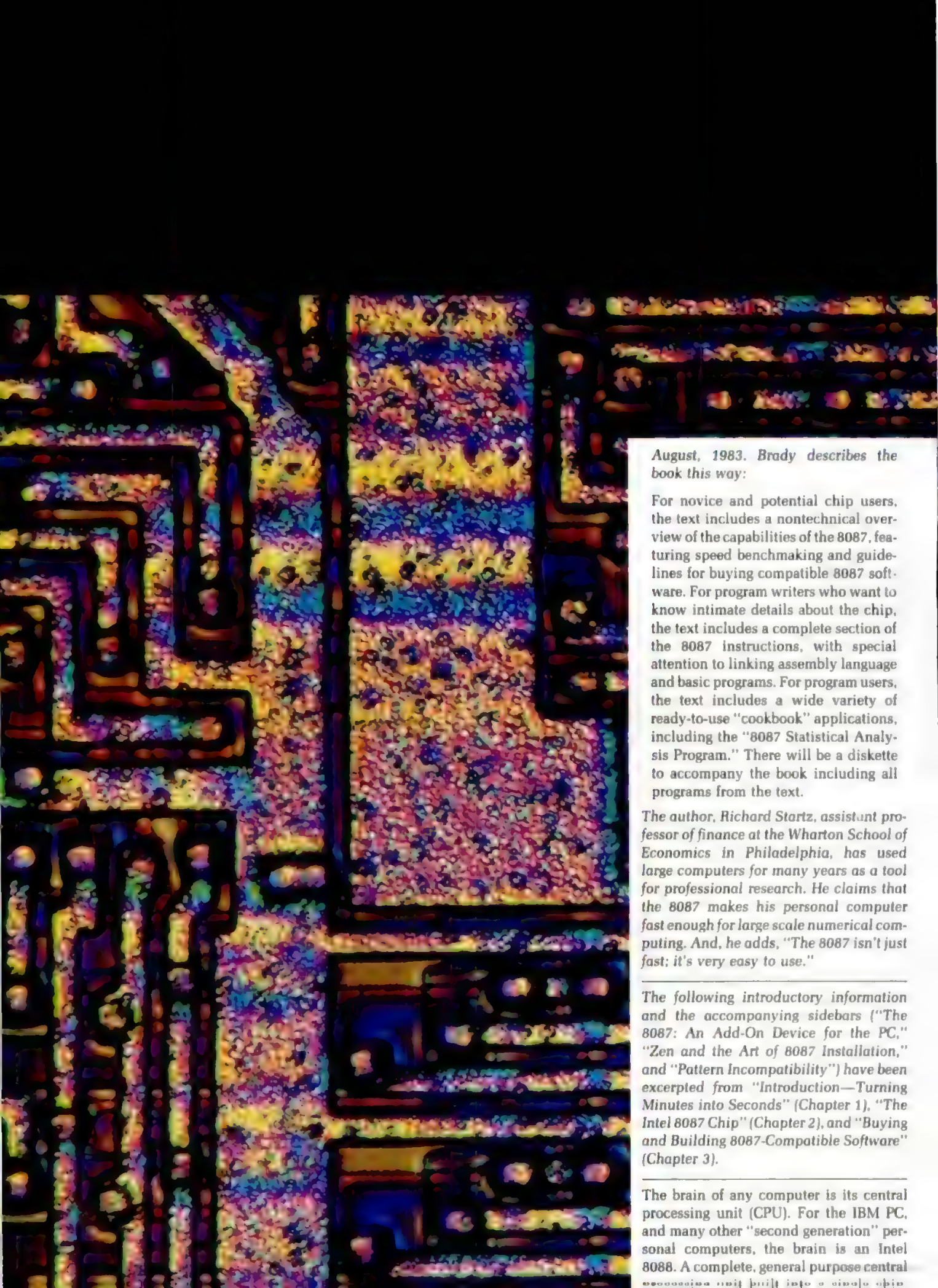
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August, 1983. Brady describes the book this way:

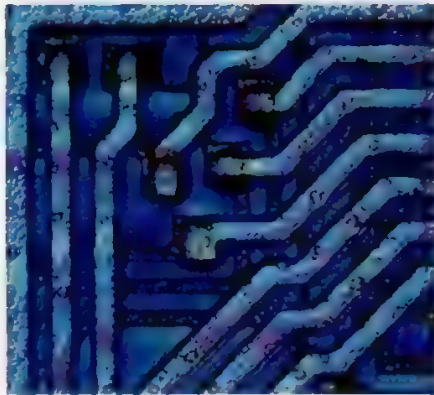
For novice and potential chip users, the text includes a nontechnical overview of the capabilities of the 8087, featuring speed benchmarking and guidelines for buying compatible 8087 software. For program writers who want to know intimate details about the chip, the text includes a complete section of the 8087 instructions, with special attention to linking assembly language and basic programs. For program users, the text includes a wide variety of ready-to-use "cookbook" applications, including the "8087 Statistical Analysis Program." There will be a diskette to accompany the book including all programs from the text.

The author, Richard Startz, assistant professor of finance at the Wharton School of Economics in Philadelphia, has used large computers for many years as a tool for professional research. He claims that the 8087 makes his personal computer fast enough for large scale numerical computing. And, he adds, "The 8087 isn't just fast; it's very easy to use."

The following introductory information and the accompanying sidebars ("The 8087: An Add-On Device for the PC," "Zen and the Art of 8087 Installation," and "Pattern Incompatibility") have been excerpted from "Introduction—Turning Minutes into Seconds" (Chapter 1), "The Intel 8087 Chip" (Chapter 2), and "Buying and Building 8087-Compatible Software" (Chapter 3).

The brain of any computer is its central processing unit (CPU). For the IBM PC, and many other "second generation" personal computers, the brain is an Intel 8088. A complete, general purpose central





**Mondrian in Silicon:** The photo below is an entire 8087 chip. All the surrounding photos are blowups of one portion or another of the 8087. The metallization and transistor interconnections form patterns pleasing to the eye. The microphotographic techniques used here enhance the appearance of the chip (actually silvery gray) with colors generated by texture differences on the surface.



sands of lines of code if implemented in software. The 8087 hardware can operate 10 to 200 times faster than equivalent software. (See Sidebar, "The 8087: An Add-On Device for the PC.")

But the single most important attribute of 8087 is its remarkable accuracy. After all, easily-written, fast-executing programs are no great trick—if you don't care about getting the right answer. The 8087 has three accuracy-enhancing features.

- Internal calculations yield 11 more

bits of accuracy than BASIC double precision numbers. That's worth three extra decimal places.

- Internal calculations have an extremely wide range. The 8087 can represent numbers as large as  $10^{4932}$  and as small as  $10^{-4932}$ . As a result, calculations rarely overflow or underflow during intermediate steps. In fact, both the precision and range of numbers are greater than those found on most traditional mainframe computers.

- The 8087 is designed to handle a



wide range of error conditions and make an automatic and graceful recovery. As a result, simple "paper and pencil" algorithms are much more likely to work. And when something goes wrong, the 8087 follows well-behaved rules instead of producing the wrong answer.

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## ***T***HE 8087-equipped personal computer is the first micro to compete economically with its larger cousins.

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### **How Fast Is Fast?**

Just how fast is an 8087-equipped PC? A good comparison can be made to either a standard mainframe computer or to a microcomputer without an 8087.

Perhaps the most remarkable statement to be made about the 8087 is that it actually makes sense to compare its speed to that of a mainframe computer costing hundreds of thousands of dollars. The 8087 is several times slower than a half million dollar machine—but then it's more than several times cheaper.

Exact comparisons are always risky, but a few numbers can give you a feeling for the speed of the 8087. Moderate speed mainframe computers require from about 1 to 5 microseconds to multiply two numbers. A supermini might require 1 microsecond. A \$50,000 tabletop mini might require about 3 microseconds. Efficient 8088 software uses about 400 microseconds to multiply two numbers (about 900 microseconds for double precision). The 8087, which is an inexpensive add-on to a personal computer, uses 20 to 30 microseconds for the same task.

For the very first time, a microcomputer is a cost-effective alternative to number crunching on large computers. The PC with 8087 is  $\frac{1}{4}$  to  $\frac{1}{20}$  the speed of a large computer at  $\frac{1}{10}$  to  $\frac{1}{100}$  of the large machine's cost. While large machines will always be more cost-effective than micros for some tasks, the 8087-equipped person-

al computer is the first micro to compete economically with its larger cousins.

Most PC owners care more about how the 8087 will speed up their personal computing than about comparisons to large central computer facilities. The speed advantage of adding an 8087 to a PC depends on the application and on how you use the 8087. The central point to understand is that the 8087 is a Numeric Data Processor. The 8087 only speeds up programs involving numerical computation. If you only use the PC for word processing, the 8087 is about 99 percent irrelevant. But if you crunch the occasional number, adding an 8087 is like trading a sparkler for the Fourth of July fireworks display.

The speed advantage of the 8087 depends very much on how you use it, but as a good overall guide: The 8087 turns minutes into seconds.

Just how much you get out of an 8087 depends on the software you use as well as the 8087's hardware speed. What the 8087 will do for you depends on how much time your software spends on various "overhead" tasks versus how much time is spent in numerical calculations. The

8087 speeds up the numerical calculations but does little or nothing about the time spent on overhead. Figure 1 shows what kind of results you can expect when you combine the 8087 with low-overhead, high-speed routines.

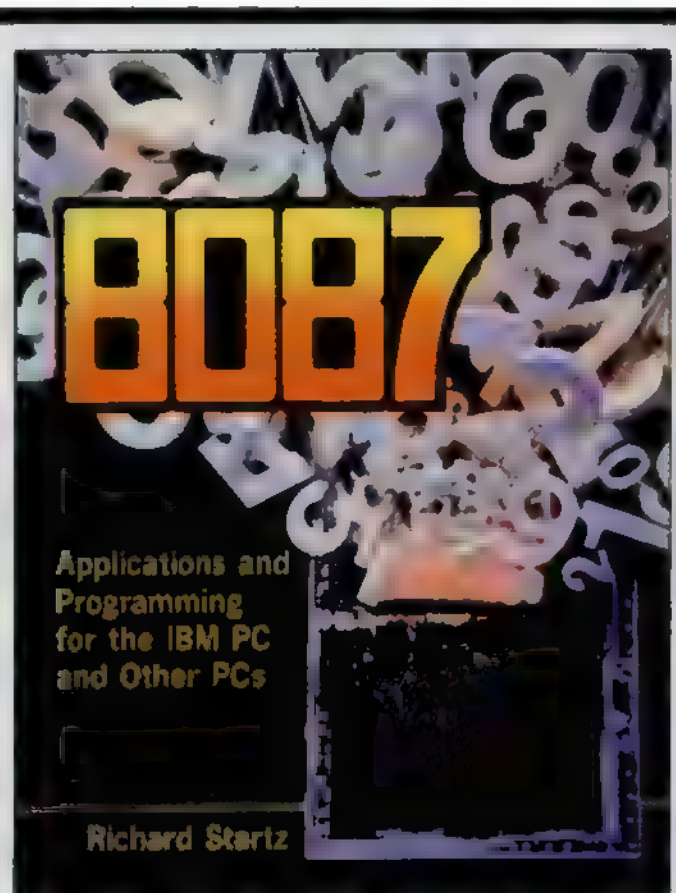
The times in Figure 1 compare (pre-8087) BASIC to special 8087 routines. The improvement is typical of what the combination of the 8087 and good software can do. Depending on the application, the 8087 hardware produces an improvement in speed by a factor of about 10 to 50—the rest is due to the low-overhead software. You won't see nearly as good an improvement if you use the 8087 with high-overhead software. (The BASIC interpreters built into a computer are, of necessity, high-overhead software.) Since the 8087 only speeds up numerical calculations, and such software spends relatively little time on numerical calculation, the sum of overhead time and numerical calculation time won't fall by nearly the amount shown in the table above. The improvement will be impressive, nonetheless.

Three basics determine an actual program's speed: the way you solve the problem (what computer scientists call the "algorithm"); your hardware's speed; and the behavior of the programming language translator. The first is always the most important. There is no computer so fast that it cannot be slowed to a crawl by a sufficiently bad way to solve a problem.

The following text is taken from "Introduction to 8087 Architecture" (Chapter 5).

### **How the Co-processor Works**

The 8087 is designed as a co-processor for the 8088 CPU. Both the 8087 and 8088 "look" at each instruction fetched from memory. The 8087 acts on its own instructions and ignores those belonging to the 8088. When the 8088 sees an 8087 instruction, which is an 8088 ESCAPE instruction, it calculates the address of any data referenced by the instruction and reads—but ignores—one byte of data from this address. Otherwise, the 8088 treats the 8087 instruction as a null operation. The 8087 copies the address calculated by the 8088 and uses it to store or fetch data to and from memory. In this way, the co-processor design allows the 8087 and the 8088 to execute simultaneously, considerably enhancing total system performance.



8087 Applications and Programming for your IBM PC and other PCs

Richard Startz

(Robert J. Brady Co., Bowie, MD, 1983)

250 pages, \$19.95

CIRCLE 687 ON READER SERVICE CARD



Figure 1. Time in seconds when 8087 is combined with high-speed routines.

Program	50 by 50 matrix multiplication	5,000 square roots
BASIC	1200	52
8087 routine	8	0.35

Figure 2: Statistics on seven regular 8087 data types.

Data Type	Bits	Significant Digits	Range
Word Integer	16	4	-32,768 to 32,767
(BASIC Integer)	32	9	$-2 \times 10^9$ to $2 \times 10^9$
Short Integer			
Long Integer	64	18	$-9 \times 10^{18}$ to $9 \times 10^{18}$
Packed decimal	80	18	18 decimal digits + sign
Short Real	32	6 or 7	$10^{-37}$ to $10^{38}$
(BASIC Single Precision)	64	15 or 16	$10^{-307}$ to $10^{308}$
Long Real			
(BASIC Double Precision)	80	19	$10^{-4932}$ to $10^{4932}$
Temporary real			

Synchronization is achieved through judicious use of the 8088 Wait instruction. The Wait instruction tells the 8088 to suspend processing until the Test line becomes active. (The 8088 checks the Test line status once every microsecond.) When the 8087 begins an instruction, it sets the Test line to inactive. It then resets the Test line to active when the instruction is complete.

#### Internal 8087 Registers

Five internal data areas are accessible by the 8087 programmer. These are the register stack, the status word, the control word, the tag word, and the exception pointers.

8087 computation is organized around eight 80-bit data registers. These registers form a pushdown stack, called the register stack. The register at the top of the stack is referred to as ST or ST(0); the register immediately below the top is ST(1); and so forth through ST(7). Many 8087 instructions implicitly reference ST(0) or

both ST(0) and ST(1). Many instructions also push data onto or pop data off of the stack. (The stack is actually organized as a chain, so that ST(0) is "below" ST(7). It is the programmer's responsibility to prevent stack overflow.)

The 16-bit status word shows the current state of 8087 operations. We make extensive use of the condition code bits in the status word, which indicate the result of 8087 comparison operations. The status word also shows whether any exceptions (computational errors) have occurred, whether the 8087 is busy, whether the 8087 has requested to interrupt the 8088, and which of the 8 stack registers is currently the top of the stack. These elements are primarily used for systems programming.

The 16-bit control word allows a number of 8087 options, described below under "control options," to be set under program control. These include the exception and interrupt-enable masks, which are primarily of interest to systems pro-

grammers. Other options, defining rounding, infinity, and precision controls, are occasionally used to control the results of numerical operations. Figure 2 shows the layout of the control word.

The tag word has 2 bits for each stack register to indicate whether the contents of the register are valid, zero, special, or empty. The exception pointers show the current instruction and operand. Neither the tag word nor exception pointers are normally of any interest to application programmers.

#### Control Options

By manipulating the control word, you can change the way the 8087 handles rounding, infinity, and precision.

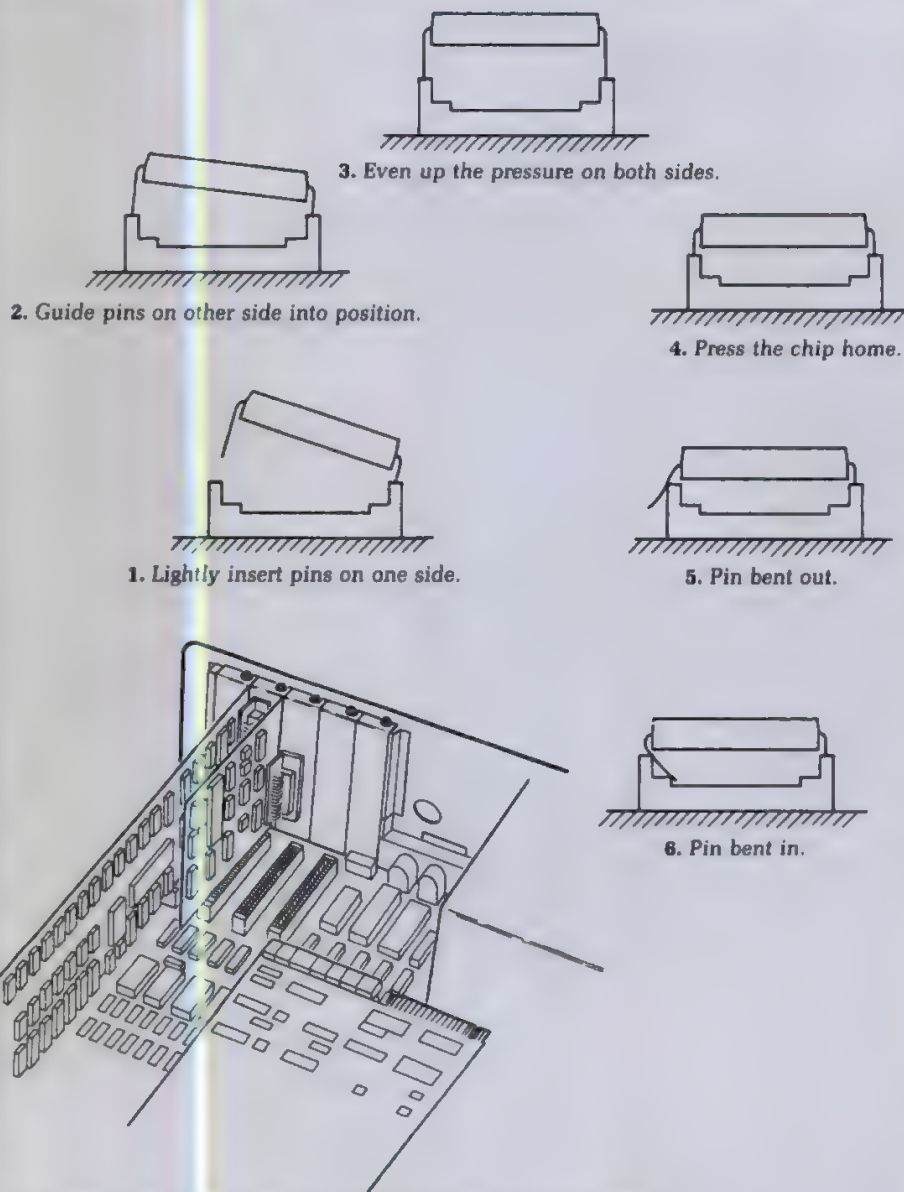
The 8087 offers four methods of rounding off answers that cannot be represented exactly in the available number of bits. The options are round to nearest, round down (toward minus infinity), round up (toward infinity), and chop (truncate toward zero). Round to nearest is the default.

The 8087, unlike most computers, has a well-defined representation of infinity. The 8087 produces the proper result when calculating mathematical functions with infinite arguments, at least when a mathematically well-defined result exists. For example, 5/infinity yields zero. Both positive and negative infinity may be represented.

**I**F YOU  
crunch the occasional  
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fireworks display.

Two modes of "infinity control" are offered on the 8087: affine closure and projective closure. Under affine closure, positive and negative infinity are regarded as being at opposite "ends" of the number line. Under projective closure, positive and negative infinity are considered equal, as if the two "ends" of the number





The 8087 nestles next to the power supply adjacent to the 8088.

## Zen and the Art of 8087 Installation

*Take these astral steps toward raising the consciousness of your PC's mind.*

Installing an 8087 in your PC need not be a traumatic experience. Granted, you paid a lot of money and got something that looks like an unimaginative mechanical rendition of a centipede. You want to do right by it and your PC, and by no means do you want to render either inoperative.

### The Proper Frame of Mind

Relax. Having turned off the power,

remove the cover from your machine at a leisurely pace. Consult the Guide to Operations. Use a ¼-inch nut driver instead of a screwdriver for true peace of mind. Gaze upon the PC's system board and contemplate the wonders of Intel's wisdom. The empty socket next to the 8088 is the Yin and the 8087 you have just purchased is the Yang. They belong together. Once you sense the rightness

of their joining, there can be no reason to keep them apart.

There are 40 pins on the 8087, harmoniously arranged into two rows of 20. They are, no doubt, embraced by a piece of conductive foam that protects the soul of the chip from the negative vibrations of static electricity. There are 40 contacts in the socket, each yearning to merge with its companion pin. Arrange yourself before your PC, placing an arm or hand on the metal chassis. Experience the joy of liberating your body from its aura of static charges. Contemplate the "I" on the 8088 and note that there is a matching "I" on the 8087. Destiny is calling them together. Orient them so that they face the same way and you will discover that the notch on the end of the 8087 respectfully faces to the rear of the machine, as do those of all other chips on the system board.

### It Happens Through You

Remove the protective foam from the pins of the 8087, taking care not to disturb their harmonious relationship through bending. Place the row of pins closest to the 8088 into the socket, holding the body of the chip at a small angle. Seat the pins lightly, making sure that all are in place. Then, focus the ki energy through your fingertips and apply a light sideways pressure to the right, guiding the pins on the left side gently into the contacts. Your eyes, guided by a deep-seated reverence for the money you parted with for the 8087, will search diligently for any pins that are misaligned. Finding none—all is in balance—press the 8087 into the socket with your thumbs. The gods will smile on your efforts. Your PC will be able to share your joy only if you move position 2 of Switch 1 to the OFF setting.

### Experience the Fullness

Sit back; allow the essence of 80-bit floating-point arithmetic to permeate your being. Feel the fluid ease with which you replace the cover, reversing the removal procedure. As you direct power into your PC, you and it will experience higher planes of consciousness and—with the proper software—true satori.

—Bill Machrone



line bent around and came together. Relative comparisons between finite numbers and infinity are permitted under affine closure, but not under projective closure. Projective closure is the default.

---

## ***T***HE EXACT bit patterns used are laid out for the computer's convenience and so are a little less than obvious to humans.

---

Precision on the 8087 can be set to 64, 53, or 24 bits of accuracy, corresponding to the temporary real, double precision, and single precision data types. This option is offered so that the 8087 may comply with certain industry standards which offer only reduced accuracy and so that 8087 computation can be made compatible with less accurate computers. Aside from the compatibility issue, the only value in using less than the full 64 bits of accuracy is the educational value of learning that more accuracy is better. Default precision is 64 bits.

### **Floating Point Numbers**

The 8087 "understands" floating point, integer, and packed decimal numbers. For number crunching, floating point numbers are by far the most important. In order to accommodate a wide range of values, computers store numbers in a "floating point" or "real" representation. Essentially, floating point is the computer's version of scientific notation. For example, in standard scientific notation the fraction "negative one-half" can be written out as

$$-5.0 \times 10^{-1}$$

Scientific notation splits the representation of a number into three sections. The "sign field" tells us the sign of the number, in the case above the leading "-" indicates a negative number. Next, the "significand field," 5.0 above, gives the number's significant digits. (The significand field is also called the "mantissa.")

The third section is the "exponent" field. The "-1" above tells us to multiply the significand by ten to the minus one power, or, equivalently, to shift the decimal point one place to the left.

The 8087 stores floating point numbers in a form of scientific notation. The exact bit patterns used are laid out for the computer's convenience and so are a little less than obvious to humans. Fortunately, we almost never need concern ourselves with such minute detail. While exact bit patterns are covered below, there are really three facts to know about each data type:

1. How many bytes of memory are used up to store a number?
2. How many digits of accuracy are retained in a number?
3. How wide is the range of numbers which can be represented; i.e., how large an exponent can be used?

The answers to 1 through 3 are shown in Figure 2.

### **Data Types**

The seven regular 8087 data types are shown in Figure 2. A brief discussion of the use of each type appears below.

**Short real.** Short real corresponds to BASIC's single precision data type. Micros have less storage than mainframe computers. Since real world data rarely has more than six or seven digits of accuracy, this data type is commonly used for economical storage of basic input data.

**Long real.** Long real corresponds to BASIC's double precision data type. As a rule, most calculations should be done in double precision in order to minimize the effect of round-off error in intermediate steps.

**Temporary real.** Whatever the data type in memory, the 8087 converts all numbers to the temporary real format for internal use. The significand of the temporary real format holds 64 bits, so that every other data type can be loaded into a temporary real without loss of precision.

By designing the 8087 around the temporary real concept, Intel has simplified the application programmer's life in several ways.

● Since all data types are converted to temporary real by the hardware, the programmer rarely need worry about explicit type conversions. It is just as easy for the programmer to multiply a double precision floating point number by a packed

decimal number as it is to multiply two integers. (Of course, when storing a number back in memory, the programmer remains responsible for ensuring that the destination data type is large enough to hold the result being stored.)

● The range for temporary reals is (almost) infinite. The exponent range is 10 to the +/-4932. As a result, overflows and underflows are almost always caused by a bug in either the data or the program, and only rarely indicate a numerical computing error.

● The temporary real has 19 significant digits. Even when a long series of intermediate calculations produces significant cumulative round-off error, the loss of 3 or 4 digits of accuracy still leaves an accurate double precision answer. With the 8087 onboard, an IBM Personal Computer is more accurate than the standard IBM mainframe!

**Word integer.** Word integer corresponds to BASIC's integer data type. A word integer occupies two bytes of storage and is principally used to index arrays and other data structures.

---

## ***B***Y DESIGNING the 8087 around the temporary real concept, Intel has simplified the application programmer's life in several important ways.

---

**Short integer.** A 4-byte integer. Not usually used in numerical programming.

**Long integer.** An 8-byte integer. Not usually used in numerical programming.

**Packed decimal.** Packed decimal representation is used for business and data processing operations. A packed decimal uses 10 bytes of memory and contains 18 decimal digits. Unlike the three preceding data types, the packed decimal form uses a decimal rather than a binary representation. Each of the decimals 0-9 is represented by four binary bits. These decimal digits are then "packed" two to a byte.



Business and data processing programs generally spend much more time converting data between external (ASCII) and internal (binary) representation than doing arithmetic. Conversion between ASCII and packed decimal representation is quite easy. (Also, some data processing languages, such as Cobol, use packed decimal representation as a standard data type.)

---

**T**HE LEADING  
bit of a floating point  
number is always a one.  
The computer shifts the  
significand left or right,  
while decreasing or  
increasing the exponent,  
in order to maintain this  
format.

---

### Floating Point Representation

8087 floating point representation makes a number of concessions to the computer's convenience.

- Numbers are represented, unsurprisingly, by a string of binary bits rather than decimal numbers.

- The position of the "binary point" is implicit. Since computer memory contains only zeros and ones, there is no convenient way to explicitly write in a decimal point. In ordinary scientific usage we write 153.7 as 1.537E2 (Computers typically use "E" in this context to indicate multiplication by a power of ten.) If our type font had no period, we might agree to write 153.7 as 1537E2 and agree that a decimal point is implicit after the first digit. On the 8087, the binary point is assumed to appear immediately to the right of the most significant bit of the significand.

- Floating point numbers are represented in a "normalized" format. The leading bit of a floating point number is always a one. The computer shifts the significand left or right, while decreasing or increasing the exponent, in order to maintain this format.

- Since single and double precision

numbers are always normalized, the leading bit is always a one and therefore needn't be stored. It isn't. The leading bit is stored in the 80-bit temporary real format.

- Exponents in scientific notation can be either positive or negative. Rather than store an explicit sign bit for exponents, the 8087 uses a "biased exponent." The exponent field holds the sum of the true exponent and a positive constant. For example, the exponent stored in a single precision real number is the true exponent plus 127. The exponent bias, chosen to provide the widest possible range given the number of bits assigned to hold the exponent, is 127 for single precision, 1023 for double precision, and 16383 for temporary real.

To illustrate floating-point representation, the significand of 2.0 is "[1]00..." (where the "[1]" indicates the leading 1 is assumed but not stored and "00..." indicates enough zeros to fill out the rest of the significand field). The exponent of 2.0, for single precision, is 127. Examples of significand and exponent fields for other numbers are:  $\frac{1}{2}$  is "[1]00..." and 126; 3.0 is "[1]10..." and 127; and 4.0 is "[1]00..." and 127.

- Zero is represented by all exponent and significant bits set to zero. (The sign bit may be either positive or negative, with-

out significance for any arithmetic or comparison operation.)

### Integer Representation

The three integer types are represented in "two's complement" format. Positive numbers are simply binary integers. Negative numbers are represented in the following way: If X is a positive integer, then -X is written as (NOT X) + 1. The leftmost bit of an integer is always a 1 for negative integers and 0 for zero or a positive integer.

### Packed Decimal Representation

Packed decimal numbers are integers represented with a sign and exactly 18 decimal digits. Bits 0-3 hold the least significant digit, i.e. the "one's place." Bits 4-7 hold the "ten's place," etc. Bits 72-78 are unused. (If an additional digit were stored here, it would not always be possible to convert a packed decimal number into an 8-byte integer.) The high-order bit, bit 79, holds the sign. If a decimal digit is not in the required range 0-9, the result of using the packed decimal number is undefined.

As an exercise, try writing out a number in each of the seven formats. (Note that 127 is 01111111 in binary or 7F in hexadecimal.)

## Pattern Incompatibility

*Combining pre-8087 software and 8087-compatible software will usually produce garbage.*

Until the introduction of the 8087, personal computers based on the 8088 family had hardware for integer arithmetic only. Since there was no hardware "with an opinion" on how nonintegers should be represented, each software designer was free to choose his or her own patterns. In practice, this meant that whoever built translators for programming languages (compilers, interpreters, and assemblers) made the decision for everyone using a particular language. Since Microsoft has been the principal supplier of programming languages for 16-bit computers, the vast bulk of software uses the patterns chosen by Microsoft.

Unfortunately, the Microsoft pattern and the Intel 8087 pattern are different.

The result of this conflict is that pre-

8087 software and 8087-compatible software cannot trade data represented in their respective internal formats. With your 8087 in place, you can safely use either pre-8087 or 8087-compatible software. If you try to combine programs produced with pre-8087 or 8087-compatible translators, you will usually get garbage. Further, if you try to exchange data between such programs you will get garbage if the data was stored using the computer's internal format. If the data is not stored in the internal format, then the programs can probably exchange data.

There isn't a general rule as to whether a conflict will occur between two pieces of software; you need to know the particulars of each program.

—R.S.



The following is an excerpt from "BASIC and the 8087" (Chapter 8).

Assembly language subroutines, in combination with BASIC programs, join the

# ***P**ACKED decimal representation is used for business and data processing operations.*

convenience of a high-level language with the speed of the 8087. In this chapter, we discuss the software conventions that must be observed in writing the 8087 routines. (If you want to use the 8087 procedures in this book for languages other than Microsoft BASIC, you may have to observe different conventions.)

## Calling a Subroutine

Calling a subroutine requires three tasks. First, we have to set up a list of arguments that can be retrieved by the subroutine. Second, we have to store away a return address in a place the subroutine can find. Third, we jump to the subroutine. The CALL instruction takes care of the latter two tasks. The first is accomplished by pushing the addresses of the arguments onto the 8088 stack.

Calling a subroutine is most easily explained with an illustration. Suppose we wanted to imitate the following BASIC code.

```
DEF SEG=&H1800
SUB=0
CALL SUB(A(0),SUM,N)
```

We could use the 8088 program in Figure 3.

1. ASSUME CS... ASSUME promises the assembler we will set up the segment registers appropriately.
2. CSEG SEGMENT CODE. Tell the assembler we are beginning the code segment.
- 3-4. MOV AX,DATA\_SEGMENT and MOV DS,AX. Put the address of the data segment into the data segment register, by transferring it through the AX register. We require two steps because the MOV

Figure 3: An 8088 program to illustrate calling a subroutine.

```

        _ASSUME CS:CSEG,DS:DATA_SEGMENT,SS:STACK_SEGMENT ; 1
CSEG    SEGMENT 'CODE' ; 2
        MOV AX,DATA_SEGMENT ;MOVE ADDRESS OF DATA ; 3
        ; SEGMENT
        MOV DS,AX ;THROUGH AX INTO DS ; 4
        MOV AX,STACK_SEGMENT ;MOVE ADDRESS OF STACK ; 5
        ; SEGMENT
        MOV SS,AX ;THROUGH AX INTO SS ; 6
        MOV SP,OFFSET STACK_ ;SET SP TO STACK TOP ; 7
        TOP
        MOV AS,OFFSET A ;PUSH ADDRESS OF A ; 8
        PUSH AX ;ONTO STACK ; 9
        MOV AX,OFFSET SUM ;PUSH ADDRESS OF B ; 10
        PUSH AX ;ONTO STACK ; 11
        MOV AX,OFFSET N ;PUSH ADDRESS OF N ; 12
        PUSH AX ;ONTO STACK ; 13
        CALL FAR PTR 1800H:0 ;CALL SUBROUTINE ; 14
NEXT_LOCATION: ;RETURN HERE WHEN SUBROUTINE ENDS
CSEG ENDS ; 15

DATA_SEGMENT SEGMENT 'DATA' ; 16
A DW 1000 DUP (?) ; 17
SUM DW ? ; 18
N DW 1000 ; 19
DATA_SEGMENT ENDS ; 20

STACK_SEGMENT SEGMENT 'STACK' ; 21
STACK_AREA DW 100 DUP (?) ; 22
STACK_TOP EQU THIS WORD ; 23
STACK_SEGMENT ENDS ; 24
END ; 25
```

instruction allows immediate operands, like an address, to be moved into memory or a general register, but not into a segment register.

5-6. MOV AX,STACK\_SEGMENT and MOV SS,AX. Put the address of the stack segment into the stack segment register. Note that we do not have to load the code segment register.

Someone else must have already done this for us since we can't execute code to load the code segment register, or to do anything else until the code segment register is loaded. The program that calls our subroutine is responsible for loading CSEG into CS. (And how does that program get CS loaded? And the one that calls it? The operating system initially loads the CS register when it first calls BASIC (or whatever). The CS value for the operating system is wired into the hardware.)

7. MOV SP,OFFSET STACK\_TOP. Set the stack pointer register to point to the memory location after the end of the stack area. We could have written "MOV SP,STACK

\_AREA + 200" with identical results. But by doing it this way, the assembler will load the correct address for the stack top even if we decide to change the size of the stack in line 22.

8-9. MOV AX,OFFSET A and PUSH AX. We now push the addresses of the arguments onto the stack, in the order of appearance in the CALL statement. Since PUSH does not allow an immediate operand, we have to go again through a general register. The assembler directive "OFFSET" tells the assembler to load the address of A rather than the value of the number stored in A. (OFFSET means use the address relative to the beginning of the segment.) The convention of passing the address of an argument, instead of its value or its name, is sometimes called a "call by address."

10-13. MOV AX,OFFSET SUM and PUSH AX and MOV AX,OFFSET N and PUSH AX. The addresses of SUM and N are pushed in a similar manner. Notice that no distinction is made between a scalar variable and the first word of an array.

14. CALL FAR PTR 1800H:0. CALL a FAR procedure. The current contents of the CS register and the Instruction Pointer (the address NEXTLOCATION) are pushed onto the stack. Then CS is set to 1800H. ("H" indicates hexadecimal to the assembler just as "&H" does to BASIC. Hex addresses start with a digit, not a letter; e.g., 0AH, not AH, so that the assembler can distinguish a number from a name.) The program then jumps to location 0 in a code segment beginning at 1800H. (Remember that segment registers always have 4 zero bits added at the right.)

15. CSEG ENDS. Tell the assembler we are ending the code segment.

16. DATA\_SEGMENT SEGMENT 'DATA.' Tell the assembler we are beginning the data segment. The compiler is smart enough to know that "OFFSET A" is an address in the data segment and that OFFSET STACK\_TOP is an address in the

stack segment.

17. A DW 1000 DUP (?). Set aside 1000 uninitialized words for A.

18. SUM DW ?. Set aside one uninitialized word for SUM.

19. N DW 1000. Set aside one word for N, initialized to 1000.

20. DATA\_SEGMENT ENDS. End the data segment.

21. STACK\_SEGMENT SEGMENT 'STACK.' Begin the stack segment.

22. STACK\_AREA DW 100 DUP (?). Set aside 100 words for the stack.

23. STACK\_TOP EQU THIS WORD. STACK\_TOP is equivalent to the address appearing after the 100 words allocated for the STACK\_AREA.

24. STACK\_SEGMENT ENDS. End the stack segment.

25. END. End the program.

The receiving subroutine finds the DS and SS registers pointing to the data and stack segments defined above. The CS register

points to 1800 hex. Most of the important information appears on the stack, which is shown in Figure 4. Remember that the 8088 stack actually grows upside down in

**IT TAKES**  
one instruction to  
retrieve the address of  
the argument; two to  
retrieve the argument's  
value.

memory, so that as we push addresses onto the stack, SP moves toward zero. Since we have pushed five words onto the stack (three argument addresses, CS, and NEXT\_LOCATION), SP equals (STACK\_AREA + 200) - 10.

Figure 4: Five words (three argument addresses, CS, and NEXT\_LOCATION) have been pushed onto this 8088 stack. Notice that SP moves toward zero.

STACK\_AREA+190      OFFSET A  
                            OFFSET SUM  
                            OFFSET N  
                            CSEG  
STACK\_AREA+190      NEXT\_LOCATION <== SP points here

Figure 5: A subroutine to add up an array of integers.

```

PUBLIC SUB                                     ;1
ASSUME CS:CSEG                                ;2
CSEG SEGMENT 'CODE'                           ;3
SUB PROC FAR                                  ;4
    PUSH BP                                     ;5
    MOV BP,SP                                  ;6
    MOV BX,[BP]+10                             ;7
    MOV SI,[BP]+6                             ;8
    MOV CX,[SI]                                ;9
    MOV AX,0                                   ;10
ADD_LOOP:                                     ;11
    ADD AX,WORD PTR [BX]                       ;12
    ADD BX,2                                   ;13
    LOOP ADD_LOOP                             ;14
    MOV DI,[BP]+8                             ;15
    MOV [DI],AX                                ;16
    POP BP                                     ;17
    RET 6                                       ;18
SUB ENDP                                     ;19
CSEG ENDS                                    ;20
END                                           ;21

```

### Acting As a Called Subroutine

Machine language subroutines called from BASIC must obey a number of rules. The important ones are as follows:

- At entry, CS is set according to the last DEF SEG. The other segment registers point to the beginning of BASIC's data area.
- At exit, all segment registers and registers SP and BP should hold their original values. The other registers, and the flags, may be changed.
- BASIC promises that the stack pointed to by SP will have eight free words. If the subroutine needs a larger stack, it must set up its own.
- The subroutine must pop the argument addresses off the stack before returning.

See Figure 5 for a subroutine, to add up an array of integers, in a form that could be called by the code sequence appearing in the preceding section.

1-3. The PUBLIC, ASSUME, and SEGMENT statements supply the usual information to the assembler.

4. PROC FAR tells the assembler that this routine will be called with a FAR CALL; information needed to generate the proper type of return instruction in line 18.

5. PUSH BP. Save the value of the BP register by pushing it onto the stack for later



retrieval. Note this instruction subtracts 2 from SP, so SP now equals STACK\_AREA + 188.

6. MOV BP, SP. Copy the stack pointer, SP, into BP. The instructions that follow retrieve information from the stack. BP can serve as a base register, as in [BP], while SP cannot.

7. MOV BX, [BP] + 10. Copy the contents of [BP] + 10 into BX. Since BP equals STACK\_AREA + 188, [BP] + 10 is STACK\_AREA + 198. STACK\_AREA + 198 holds OFFSET A, so after this instruction BX holds the address of the first word of A.

8. MOV SI, [BP] + 6. By the same logic, move the address of N into SI.

9. MOV CX, [SI]. Now move the value of N into the count register, CX.

10. MOV AX, 0. Clear out the accumulator, AX.

11. ADD\_LOOP: . Label the top of the loop. Notice that this loop does not worry about errors such as negative or zero N nor about the accumulator overflowing. (Not very good programming practice!)

12. ADD AX, [BX]. Add the element of A currently pointed to by BX into AX. The first time through, this is A(0); the second time, A(1); and so forth.

13. ADD BX, 2. Increment BX by 2 so it points to the next word.

14. LOOP ADD\_LOOP. Decrement the count register and jump back up to the top of ADD\_LOOP if we haven't run the count down to zero.

15. MOV DI, [BP] + 8. Move the address of SUM into DI.

**ANY**  
*subroutine that  
explicitly contains a  
value for a segment  
register is not  
relocatable.*

16. MOV [DI], AX. Move the contents of AX into the address pointed at by the DI register, i.e., into SUM.

17. POP BP. Now restore the original value of BP. Also, add two to SP.

18. RET 6. Set the Instruction Pointer to

point to NEXT\_LOCATION and set CS equal to CSEG, in the process add 4 to SP. Add the optional pop value to SP. Now SP equals STACK\_AREA + 200, as it did before the subroutine was called.

19-21. SUB ENDP and CSEG ENDS and END. Tell the assembler to close up the procedure, segment, and program.

In coding the subroutine, a pattern appears.

- If the subroutine is called with n arguments, then the address of argument i is stored in [BP] + 6 + 2\*(n-i). In other words, the right-most argument has its address stored at [BP] + 6; the right-most-but-one is at [BP] + 8; one further to the left is at [BP] + 10; and so forth. (These are addresses are valid after we set BP, as in lines 5 and 6, with a PUSH and a MOV.)

- It takes one instruction to retrieve the address of the argument; two to retrieve the argument's value.

- The last instruction should be RET 2\*n, where n is the number of arguments.

### Subroutine Relocation and Segment Addressing

The BASIC command BLOAD allows us to load a subroutine at any memory location. It is therefore highly desirable that our 8087 routines be dynamically relocatable. We can run into difficulty if the segment addresses at which a routine

is initially loaded differ from those at which we later BLOAD the routine. Dynamic relocation is automatic for programs that do not explicitly reference seg-

**S**UBROUTINE  
*SILLY will work if  
loaded and used at one  
location, since the  
loader will figure out  
the value of  
EXTRA\_SEG.*

ment locations, but somewhat more complicated otherwise.

For the purposes of this discussion, suppose we had initially loaded SUB with DEF SEG=&H1800 and the BSAVED it from this location with an offset of 0.

Suppose we now loaded SUB back in at DEF SEG=&H1900. When BASIC calls SUB, it sets the code segment register to &H1900 and the instruction pointer to zero. Execution proceeds correctly.

Suppose instead that we load SUB at DEF SEG=&H1900 and offset 125. SUB

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tems for different uses.

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Figure 6: The subroutine SILLY above illustrates the problems of defining an extra segment inside a routine.

```

EXTRA_SEG SEGMENT 'DATA'                                :1
FOOLISH      DW ?                                       :2
EXTRA_SEG ENDS                                          :3
:SUBROUTINE  SILLY(JUNK%)
    PUBLIC SILLY                                         :4
    ASSUME CS:CSEG,ES:EXTRA_SEG                          :5
CSEG SEGMENT 'CODE'                                     :6
SILLY PROC FAR                                         :7
    PUSH BP                                             :8
    MOVE BP,SP                                           :9

    PUSH ES                                             :10
    MOVE AX,EXTRA_SEG ;POINT ES                        :11
    MOVE ES,AX                                           :12

    MOVE AX,FOOLISH ;RETURN WHATEVER                    :13
    MOVE DI,[BP]+6 ;NUMBER WAS                          :14
    MOVE [DI],AX ;LAYING AROUND                         :15
    POP ES                                              :16
    POP BP                                              :17
    RET 2                                                :18
SILLY ENDP                                             :19
CSEG ENDS                                              :20

END                                                    :21

```

"thinks" it will find the first instruction at offset zero in the code segment. Actually, the first instruction is at offset 125. However, when we call SUB we specify the offset. BASIC sets the instruction pointer to 125. All the instructions we have used, though not every instruction the 8088 knows, operate relative to the instruction pointer. SUB still executes correctly.

SUB is fully relocatable. What sort of subroutine isn't? Unfortunately, any subroutine that explicitly contains a value for a segment register is not relocatable, since the segment may end up at some other memory location than the one originally specified. This is particularly a problem when we define a data, extra, or stack segment inside a routine. Consider the not very useful routine in Figure 6.

This subroutine references the extra segment (if not to any good purpose). Instructions 1-9 and 14-21 are standard. Lines 10, 11, and 12 save ES on the stack and then load the address of EXTRA\_SEG into ES. Line 13 copies FOOLISH. (Note that the assembler should be smart enough to use ES to reference FOOLISH.) Subroutine SILLY will work if loaded and used at one location, since the loader will figure

## THE 8088 requires segments to be placed at addresses that are even multiples of 16.

out the value for EXTRA\_SEG. However, if we relocate SILLY, EXTRA\_SEG will no longer be at its original location, and unpredictable consequences may ensue.

We can make SILLY relocatable by having the subroutine figure out for itself how far it's been moved from its original location. The subroutine "thinks" it begins at location 16\*CSEG. In truth, when BLOADED by interpreted BASIC, SILLY begins at 16\*DEF SEG + offset. Similarly, the subroutine thinks the extra segment begins at 16\*EXTRA\_SEGMENT, while it actually begins at 16\*EXTRA\_SEGMENT + (16\*DEF SEG + offset - 16\*CSEG). We

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Figure 7: Subroutine SMART with the code segment and extra segment loaded together at a memory location that is an even multiple of 16.

```
EXTRA_SEG SEGMENT 'DATA' ;1
FOOLISH DW ? ;2
EXTRA_SEG ENDS ;3

;SUBROUTINE SMART (JUNK%)
PUBLIC SMART ;4
ASSUME CS:CSEG,ES:EXTRA_SEG ;5
CSEG SEGMENT 'CODE' ;6
FIRST_INST EQU THIS WORD ;7
SMART PROC FAR ;8
PUSH BP ;9
MOV BP,SP ;10

PUSH ES ;11
CALL NEXT ;12
NEXT: POP AX ;13
SUB AX,(OFFSET NEXT)-(OFFSET FIRST_INST) ;14
MOV CL,4 ;15
SHR AX,CL ;16
MOV BX,CS ;17
ADD BX,EXTRA_SEG ;18
SUB BX,CSEG ;19
ADD AX,BX ;20
MOV ES,AX ;21

MOV AX,FOOLISH ;22
MOV DI,[BP]+6 ;23
MOV [DI],AX ;24
POP ES ;25
POP BP ;26
RET 2 ;27
SMART ENDP ;28
CSEG ENDS ;29
END ;30
```

can use this relation to correctly load segment registers. Life is complicated a slight bit more because the only way to find "offset" is by examining the value of the instruction pointer at entry.

The following subroutine, SMART (see Figure 7), will work correctly, as long as the code segment and extra segment are loaded together at a memory location that is an even multiple of 16.

Lines 1-6, 8-10, 22-24, and 27-30 are standard.

7. FIRST INST EQU THIS WORD. Define the location of the first instruction in the code segment to be FIRST \_ INST. (FIRST \_ INST equals zero here.)

11. PUSH ES. Save ES on the stack. Note we don't change BP so argument references don't change.

12-13. CALL NEXT and NEXT: POP AX.

**THIS**  
*manipulation is worth  
the extra trouble to  
more easily load  
subroutines into BASIC.*

This is a devious way to retrieve the instruction pointer. CALL pushes IP onto the stack. (The instruction pointer will point to the true offset of NEXT, no matter where the routine is located.) POP pops the stack into AX. Now AX holds the true offset of NEXT.





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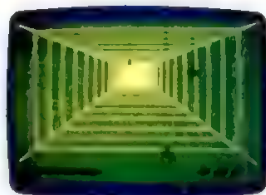
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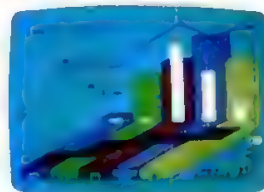
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14. SUB AX, (OFFSET NEXT)-(OFFSET FIRST\_INST). Now we subtract the expected offset of NEXT from the true offset. AX now holds the number of bytes by which the offset of SMART has changed as compared to the position at which it was originally loaded.

15-16. MOV CL, 4 and SHR AX, CL. Divide AX by 16 since we are going to set a segment register. Notice that if the program was relocated by any number other than an even multiple of 16, the program will bomb in an unpredictable manner. Nor will any other method work, since the 8088 requires segments to be placed at addresses that are even multiples of 16.

17-19. MOV BX, CS and ADD BX, EX-

TRA\_SEG and SUB BX, CSEG. Figure out how far the code segment has been displaced from its original location and how far the extra segment is from the code segment.

20-21. ADD AX, BX and MOV ES, AX. Combine the offset and segment correction and set ES.

25. POP ES. Restore ES before leaving the routine.

While all this manipulation is a bit of a nuisance, it is worth the extra trouble to be able to more easily load subroutines into BASIC. If you only use a compiler, then relocation is handled by the LINK program and this extra code is unnecessary.

Figure 8: An interactive session for loading FOO into interpreted BASIC. Your responses have been underlined.

```
B>A: MASM:
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0004 E8 0007 R          CALL NEXT
      ;12
E R R O R ——— 64:NEAR JMP/CALL TO DIFFERENT CS

WARNING SEVERE
ERRORS  ERRORS
0      1
B>A: LINK
```

```
IBM PERSONAL COMPUTER LINKER
VERSION 1.10 (C)COPYRIGHT IBM CORP 1982
```

```
OBJECT MODULES [.OBJ]: FOO/HIGH/MAP
RUN FILE [FOO.EXE]:
LIST FILE (NUL.MAP): FOO:
WARNING: NO STACK SEGMENT
```

THERE WAS 1 ERROR DETECTED.

```
B> TYPE FOO. MAP
LOADING HIGH
```

```
WARNING: NO STACK SEGMENT
START  STOP  LENGTH NAME          CLASS.
00000H 0002AH 002BH  CSEG          CODE
00030H 00031H 0002H  EXTRA_SEG DATA
```

ADDRESS PUBLICS BY NAME

```
0000:0000 SMART
```

```
ADDRESS PUBLICS BY VALUE
continued on next page
```

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### Loading Assembly Language Programs

At the end of the chapter, we show two complete interactive sessions in which SMART is used in a BASIC program: one session for the interpreted BASIC built into the IBM Personal Computer and one session for IBM's BASIC compiler. The

remainder of this chapter describes the general steps involved. These procedures focus more specifically than most of the material in the book on the IBM Personal Computer running PC-DOS. If you have a different machine or different software (especially if you are not using Microsoft software), you may have to adjust these

Figure 8 continued

```
0000:0000 SMART
B> A: DEBUG A: BASIC.COM
-R
AX=0000 BX=0000 CX=3F80 DX=0000 SP=FFFE BP=0000 SI=0000 DI=0000
DS=0905 ES=0905 SS=0905 CS=0905 IP=0100 NV UP DI PL NZ NA PO NC
0905:0100 E9E338 JMP 39E6
-N F00.EXE
-L
-R
AX=FF47 BX=0000 CX=0080 DX=0000 SP=0000 BP=0000 SI=0000 DI=0000
DS=0905 ES=0905 SS=4F94 CS=4F94 IP=0000 NV UP DI PL NZ NA PO NC
4F94:0000 55 PUSH BP
-RSS
SS 4F94
: 905
-RSP
SP 0000
: FFFE
-G=905:100
DIRECT STATEMENT IN FILE

OK
DEF SEG=&H4F94
OK
BSAVE "F00.SAVE",0,&H31
OK
SYSTEM
PROGRAM TERMINATED NORMALLY
-Q
B>A:BASIC
THE IBM PERSONAL COMPUTER BASIC
VERSION D1.10 COPYRIGHT IBM CORP. 1981, 1982
61371 BYTES FREE
OK
LOAD "USEF00"
OK
RUN
9999
0
OK
```

continued next page



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procedures somewhat.

### Loading a Routine into Interpreted BASIC

The assembler transforms an 8087/8088 source program into an object module. Several further steps are required to

**THE**  
*assembler transforms an  
8087/8088 source  
program into an object  
module.*

get the routine into a form suitable for BLOADing into BASIC. These steps involve running the program through the LINKer, through DEBUG, and finally through BASIC. Suppose we begin with a program held in file FOO.ASM.

The assembler replaces the instructions and (most) addresses with their binary representation and creates a file FOO.OBJ.

LINK is able to combine several different object files. It creates FOO.EXE.

We use DEBUG to load FOO.EXE. DEBUG figures out the actual memory address at which each segment begins. We can also ask DEBUG to tell us where the program begins.

Finally, we use BASIC to BSAVE the routine. Once the routine is BSAVED, we can BLOAD it whenever desired.

The exact procedure for getting from FOO.ASM to the BSAVED version is described in Appendix C of the IBM PC BASIC Manual. (The descriptions of LINK and DEBUG in the DOS manual supply some additional information.) The exact procedure may vary according to which version number DOS and BASIC you use. The steps described below usually work for the author.

1. Assemble FOO.ASM (Be warned that the assembler occasionally produces erroneous error messages.)
2. Link FOO.OBJ. Tell the linker to load HIGH (LOW is the default). Get a MAP file from LINK so that you can find the total length of the output file, FOO.EXE. If FOO

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doesn't have a stack segment, LINK will report its absence as an error. Ignore this message.

3. Enter the DEBUGer with DEBUG BAS-  
SIC.COM.

4. Type "r" to examine the registers. Copy  
down the values of CS, SS, IP, and SP.

5. Enter "N FOO. EXE." Type "L." This  
tells DEBUG to load your routine.

**W**E CAN  
ask DEBUG to tell us  
where the program  
begins.

6. Type "r" again. Copy down the new  
values of CS and IP.

7. Restore SS and SP by using the r com-  
mand. Enter "RSS." The computer will  
tell you the current value of SS. Respond  
by entering the value of SS you copied  
down in step 4. Now enter "RSP" and  
respond to the computer with the value of  
SP from step 4.

8. Enter "g=CS:IP" where CS and IP are  
replaced by the values copied down in  
step 4.

9. BASIC should start up now, possibly  
with an irrelevant warning about a  
DIRECT STATEMENT IN FILE. Execute  
DEF SEG=cs, where cs is the value of CS  
copied down in step 6. Execute a BSAVE

Figure 9: An interactive session for loading FOO into compiled BASIC. Your responses  
have been underlined.

```
B>A: MASM;
THE IBM PERSONAL COMPUTER MACRO ASSEMBLER
VERSION 1.00 (C)COPYRIGHT IBM CORP 1981

0004 E8 0007 R      CALL NEXT
      ;12
E R R O R  —  64:NEAR JMP/CALL TO DIFFERENT CS

WARNING SEVERE
ERRORS  ERRORS
0       1

B>A: BASCOM USEFOO;

IBM PERSONAL COMPUTER BASIC COMPILER

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(C)COPYRIGHT MICROSOFT, INC. 1982

22151 BYTES AVAILABLE
22032 BYTES FREE
0 WARNING ERROR(S)
0 SEVERE  ERROR(S)

B>A: LINK USEFOO+FOO;

IBM PERSONAL COMPUTER LINKER
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B>USEFOO
9999
0
```

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STATEMENTS

MESSAGES

EDITOR

COMMANDS

filespec, offset, length command; where filespec gives the name of the file in which you wish to save the routine, offset is the value of IP from step 6, and length is the length in bytes of FOO.

From now on to use FOO from BASIC just do a "DEF SEG=" and "BLOAD filespec."

### Loading a Routine into Compiled BASIC

Combining an assembled program with the output of the PC-BASIC compiler is considerably easier than loading the program into interpreted BASIC.

1. Assemble FOO.ASM. Include subroutine names in a PUBLIC statement.
2. Compile the BASIC program. Omit DEF, SEG, and BLOAD statements. You need not worry about the location of the subroutine in memory.
3. LINK the output of the BASIC compiler together with FOO.
4. Execute the ".EXE" module.

### Interactive Session for Interpreted BASIC

Assume that the routine SMART is in file FOO.ASM on disk B:. The following BASIC program is in a file USEFOO.BAS, also on disk B:.

```
10 DEF SEG=&H1800
20 BLOAD 'B:FOO.SAV',0
30 SMART%=0
40 FOOLISH%=9999
50 PRINT FOOLISH%
60 CALL SMART%(FOOLISH%)
70 PRINT FOOLISH%
80 END
```

See Figure 8 for a sample interactive session for loading FOO into interpreted BASIC.

### Interactive Session for Compiled BASIC

Assume that the routine SMART is in file FOO.ASM on disk B:. The following BASIC program is in a file USEFOO.BAS, also on disk B:.

```
10 FOOLISH%=9999
20 PRINT FOOLISH%
30 CALL SMART(FOOLISH%)
40 PRINT FOOLISH%
50 END.
```

See Figure 9 for a sample interactive session for loading FOO into compiled BASIC.

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Total	1000.00	Amount	100.00
Cost of Loan	100.00	Payment	100.00
Cost of Loan	100.00	Term	36 Months
Cost of Loan	100.00	Start Date	07/01/83
Cost of Loan	100.00	Amount	100.00
Cost of Loan	100.00	Payment	100.00
Cost of Loan	100.00	Term	36 Months
Cost of Loan	100.00	Start Date	07/01/83
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Cost of Loan	100.00	Payment	100.00
Cost of Loan	100.00	Term	36 Months
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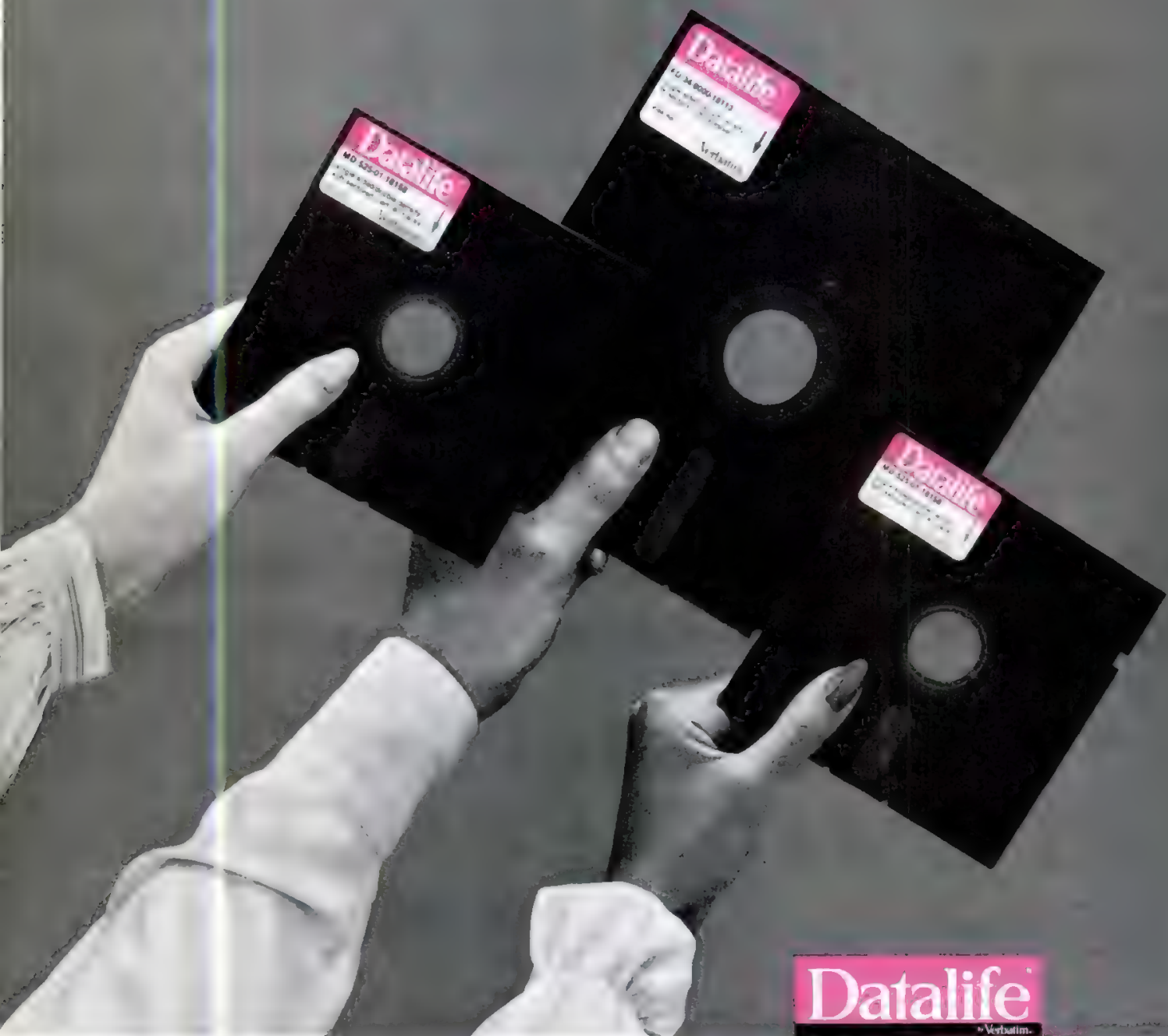
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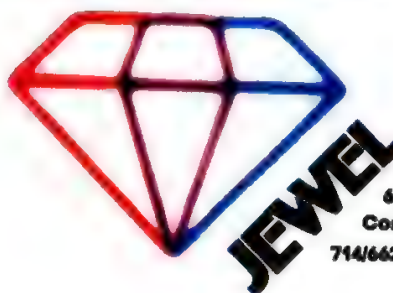
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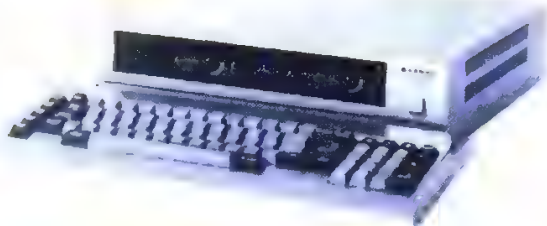


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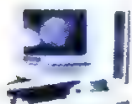
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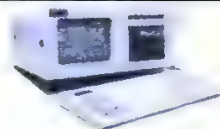


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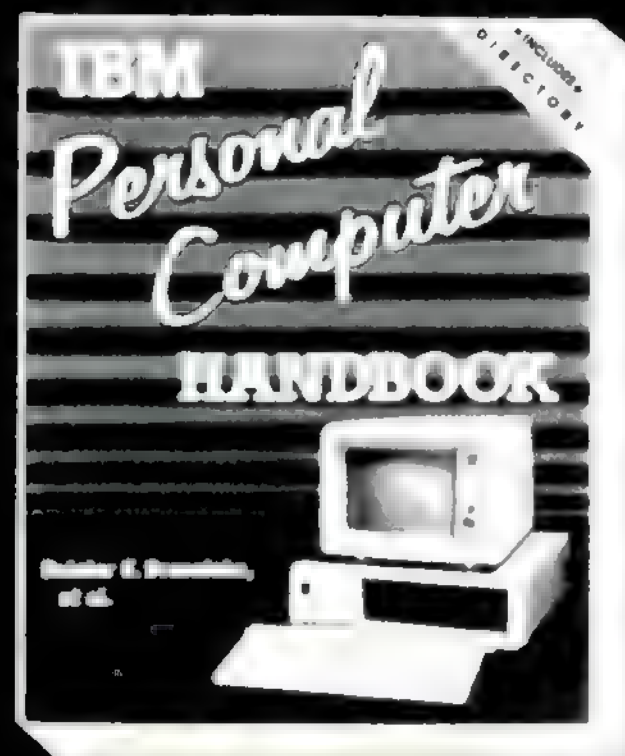
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*A home chess master engages two new programs for the PC. His recommendations: Read up and wait for something better to come along.*

# Biding Your Time With Computerized Chess

---

## Chess Partner

Scott Murray Software  
3326 Granada Ave.  
Santa Clara, CA 95051

**List Price:** \$24.50

**Requires:** 128K, one disk drive, DOS 1.1, color monitor.

---

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In creating games for personal computers the designer is confronted with a choice of two routes. He may, on the one hand, wish to take advantage of the computer's graphics and sound capabilities and build a game around them. Space Invaders is a classic example of this sort of game. Without computers there would be no Space Invaders. Alternatively, the designer may simply wish to take an existing board, card, or word game and write a computer version of it. Since the computer may be

programmed to take the place of a human opponent, two-participant games, such as chess, are particularly appropriate for computerization.

The difficulty in programming chess or any other game, such as bridge or checkers, is that while it is straightforward enough to write a program to "play" chess, it is quite another matter to write a program that challenges the average chess player.

---

**T**HE COMPUTER  
*may be programmed to  
take the place of a  
human opponent.*

---

As a chess master and professional programmer, I have always looked at chess programs with interest. I was especially intrigued to learn that two had recently been written for the IBM PC. After all, a very reasonable chess program, Sargon, had been written years ago to run with 8K on a Z80-based system. Since software

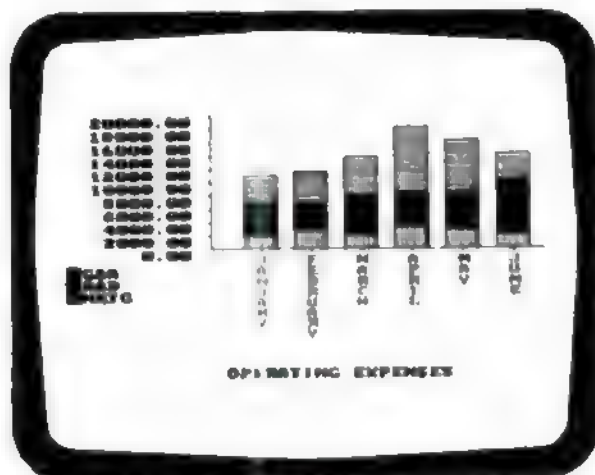
marketeers may reasonably assume that a PC will have at least 64K of memory and one disk drive, a much more sophisticated program should be very easy to produce. In addition, the 8088 processor is much more sophisticated than the Z80. It is faster and its instruction set is far more powerful. Last, and not least, the PC has more than adequate graphics capabilities that can be used to produce a lifelike chessboard. The original source code for Sargon was published as a book in 1978. Its authors, Dan and Kathe Spracklen, wrote a very readable manual for producing a chess game on a microcomputer.

## Howdy, Partner

The first PC chess program to reach my desk, Chess Partner, by Scott Murray Software, came in an attractive little folder that coordinates pleasingly with my shelf of IBM software. The documentation, though it was typeset, was limited to a very brief three and a half pages. To my amusement it did not explain the rules of chess. This does not seem to be a great hardship. One of the advantages of computerizing games such as chess is that most purchasers of the software already know how to play the game. The booklet also had the annoyingly consistent prob-



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lem of spelling en passant as en passant. This made me worry a bit about how much chess the author or authors ever played.

To my astonishment the program requires 128K and a color/graphics board. Since chess games have been programmed in as little as 2K, 128K can only be consid-

***I** F I EVER  
have need of a  
cockroach on a graphics  
display I will not  
hesitate to model it after  
the Black Queen in  
Chess Partner.*

ered excessive. It's totally unnecessary for a good game which alas, Chess Partner does not provide. After trundling over to the local ComputerLand, which kindly provided me with a PC-XT, I tested Chess Partner's prowess. After prompting me for one of six skill levels, it asked whether I preferred White or Black. Being an experienced chess player and no fool, I set the game's skill level at one, the lowest, and chose the White pieces.

Now, I consider myself an open-minded person when it comes to graphics displays on computers. I realize that I am not going to get a display that is as pleasing to the eye as a fine walnut and maple chessboard with a set of classically designed Staunton chessmen handmade in boxwood. On the other hand, I certainly was not prepared for what I saw next. A purple and pink chessboard took form before my eyes, followed by the most unprepossessing set of chessmen I have ever seen. These pieces did not attempt to duplicate any design ever used in printed chess diagrams. The knight was recognizable, though a bit squashed, the rook wasn't too bad, but the bishops and pawns appeared to have melted into shapeless globules. The queens were truly astounding. If I ever have need of a cockroach on a graphics display I will not hesitate to model it after the Black Queen in Chess Partner. It actually has two little legs. Apparently it also exhausted the creative energies of the

designers who gave up on the king, which is simply represented by a large K.

As for the game itself, Chess Partner wants moves entered in what is known as long-form algebraic notation. If I move my king pawn up two squares I must enter e2 e4. It would be convenient if the game allowed you to use descriptive notation (P-K4) or short form algebraic (e4). The first format is more common, the second is quicker. However, entering e2 e4 is no real hardship, and I'm sure this has helped to keep the program from growing beyond 128K.

### Leveling Out

On level one, Chess Partner replies almost at once. It only expended a total of 7 seconds to lose the first game: 1. e4 e5 2. Bc4 Nf6 3. Nc3 Bb4 4. d3 B:c3+ (at a second a move Chess Partner was no doubt delighted to have something to capture) 5. bc3 d5 6. ed5 N:d5 7. Qf3 (Let's see how it responds to cheap threats) N:c3 ?? 8. Q:f7 mate (not well). So much for wondering about alpha/beta pruning or whether some new method of move parsing has been discovered.

Now perhaps this wasn't entirely fair on my part. So I reset the ability level to two and tried again. 1. c4 d5 2. cd5 Nd7 (at least Chess Partner is original.) This move, however, loses a pawn. I won quickly while gorging myself on Black pieces. This was beginning to pose a dilemma. Chess Partner's instructions indicate it has only six levels of skill, the last three of which "are deemed too slow for normal games." Since ComputerLand has at least some passing desire to sell the system I was using, I wasn't at all enthusiastic about starting a game at a higher level. A normal tournament game runs about 4 hours. I shuddered to think how many meals I would miss at level six. So I tried the manual's suggestion of using the higher levels to solve a problem. I went back to the menu and selected problem mode. Chess Partner then went through all 64 squares of the board, prompting me to enter a piece. I decided to give Chess Partner a devious computer chess problem. White king on c2, a White pawn on g7, and the Black king on a1. White is to move and mate in two moves. Since 1. g8=(Q) is stalemate, the solution is 1. g8=(R)! Ka2. Ra8 mate. This little problem, published in 1868 by E. B. Cook, is devious only because so many computerized chess



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games don't know the rules about under-promotion. They only allow queens. Chess Partner was no exception. It whirled and ground for 7½ minutes and played 1. Kc1. Further investigation revealed it only allows pawns to be promoted to queens and knights! Amazing. A computer chess game ought to at least play by the rules of chess. Anything less is totally unprofessional programming practice akin to writing a General Motors payroll system that doesn't allow for an income tax in State of Michigan.

So much for higher levels of play. I set Chess Partner back to level three, described as "slow, but very smart and aggressive." The game proceeded 1. e4 e5 2. d4 ed4 3. c3. This is known as the Danish Gambit. After waiting for more than 10 minutes for Chess Partner to reply, I wished I had a Danish to munch on. Since this is totally outrageous (A 40-move game was going to take at least 6 hours if I responded instantly), I aborted the game and called it a day.

### No Sicilians and Other Complaints

I also discovered a number of other interesting features of Chess Partner. Pressing Esc aborts the game. This is nice, but if you press the key accidentally, the game is over. There is no prompt to ask whether you really intend to quit play. Since Escape and 1 are next to each other on the PC's keyboard, it is very easy to perform the electronic equivalent of throwing the board and pieces at your opponent.

Chess Partner wants you to castle by capturing your king with your rook. This is all right, but it would have been nicer to have simply been allowed to move my king two squares, as in a real game. Chess Partner is endowed with an opening "book" that allows it to respond quickly on the first two moves. Common sequences are hard-coded in the program while it stores unusual sequences in a small disk file. If you open 1. e4 it responds 1... e5 instantly, while if you try 1. a4 it reads the diskette and then plays 1... e5. You will notice that I said "it responds 1... e5." That's right. It only plays 1... e5 in response to 1. e4. No Sicilians, Frenches, Pircs or anything else. If you don't think this is a drawback, about ten games will convince you otherwise.

You can't practice against a variety of openings. I tried setting up the first moves of the Sicilian Defence, 1. e4 c5, which was tedious to start with, but which revealed another problem with Chess Partner: If you set up a position, it always moves first.

Chess Partner also has some bugs. It wouldn't allow Black to castle queenside, though White could. It also has some problems displaying its menu screen properly.

### No Game Is All Bad

There are some features of Chess Partner that I like. It has two clocks that display the elapsed time of each player and even tick audibly. I'm glad the authors took advantage of the PC's clock to do this. The ticking can be turned off if it bothers you. Being a tournament player who plays most games with clocks, I found I actually preferred the ticking sound to the eerie quiet of Chess Partner's interminable thinking. Chess Partner also allows you to change the skill level at any time and to retract moves. I know real chess players can't take back moves, but part of the reason to have a computer chess game is to practice. The manner in which Chess Partner retracts moves is another thing. It sets up a fresh board and proceeds to replay the entire game except the last move. I'm glad I didn't retract the last move of a 60-move game! While this method might entertain the neighborhood children, it is slow and unnecessary. Since Chess Partner obviously retains all of a game's

**I** **ACTUALLY**  
*preferred the ticking  
sound to the eerie quiet  
of Chess Partner's  
interminable thinking.*

moves, it could just play the last move in reverse (e4- e2 instead of e2- e4).

Chess Partner also is not copy-protected, and the publishers offer to replace any defective diskettes within 60 days after purchase with a "sincere apology."

I like Scott Murray's attitude in regard



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to copy protection and replacement. The publishers seem well-intentioned, but this product should not be on the market. It is inadequate and unfinished. The programming is unprofessional, and no care was taken to make the game easy to use. A lot of work needs to be done.

### Here Comes the Master

The second chess game appeared several weeks later in my mailbox. It has the terribly pretentious name of SPOC, the Chessmaster. SPOC stands for Selective Pruning Optimization Chess, which the authors claim is a new algorithm for the game.

Anyway, the instructions for SPOC won't tell you how to play chess. They do tell you, however, about going to jail if you steal the program and about how you are going to be out of luck in the case of a bad copy. SPOC is copy-protected, but the diskette is only warrantied for 90 days. Worse, if you get a bad copy it will cost you \$4 to have it replaced. This is an outrage. Regardless of what merits the game may have, I would not buy it for this reason alone.

Like Chess Partner, SPOC devours 128K of memory, but it at least gives you the option of using a nongraphics monitor. I feel this is an essential of a good chess program. After all, chess is not really a very graphic game. The only reason for graphics at all is so that you won't have to use a chess board.

Feeling that I might have worn my welcome a bit thin at ComputerLand, I went to Computer Mart with SPOC. Again I was kindly provided with an XT for my use. So I booted up DOS and inserted SPOC. The instructions for the program dwell upon this procedure for two entire pages in what I would not consider to be the most illuminating introduction to using diskettes under MS-DOS. SPOC then prompts for a level of play (1-9). The authors have the courtesy to tell you how much time SPOC will spend on its moves at each level. At level 1 SPOC will spend about 10 seconds per move. At level 9 it will take 60 minutes. Unless you are running a business burning-in PCs, I would suggest you not play any game at 60 minutes per move. The authors mention that level 6, which plays at 3 minutes per move, is tournament level. This corresponds to 40 moves in 2 hours, a somewhat slow time limit for American tourna-

ments, but within reason. You could play a game in about 4 hours at this speed.

SPOC then asks whether you are using a color/graphics display and if you want the moves output to a printer. This is a nice idea. You can get a hard copy of a game as you are playing it. Since SPOC will save games on a diskette if you desire, it also asks whether you wish to resume a previous game that you saved on a diskette. At level 9 you probably will save your game frequently. Finally, SPOC asks whether you want White or Black.

### To the Board

SPOC next displays the board. Lo and behold! It's also pink and purple. I bet all these authors wish IBM sold a pink monitor. SPOC features, however, a very attractive set of pieces. They look very much like a chess diagram and are easy on the eyes. I'm glad the authors recognized that hundreds of years of experience in publishing chess programs may have led to something aesthetically pleasing.

SPOC has you move the pieces in an

unusual manner. You use the arrow keys to position the cursor over the piece you want to move, then press Home. SPOC "picks up" the piece slightly. You then

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*get a hard copy of a  
game as you are playing  
it.*

move the cursor to the square you want and press Home again to complete the move. If you change your mind about moving a piece, just put it back on its original square and press Home. This sounds easy, but is very laborious. The cursor is not easy to spot and you may make a lot of keystrokes for a move.

After SPOC replies, you must busily search for the cursor. Good luck. It's not

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there. Experimentation reveals that it's on the square where SPOC moved its piece. It just doesn't show it to you. The more I used the cursor the less I liked it. The algebraic notation used by Chess Partner is preferable. SPOC will display captured pieces alongside the board and show you how much time was taken per move. I dislike this scheme. I would have been satisfied to see the elapsed times for the whole game, as you would in a tournament.

### Balance Sheet

SPOC is a much better chess player than Chess Partner. The various levels provide a usable range of time limits, the display is good, and it really does play reasonably. This is not to say SPOC is not without problems. It is shot through with them. First of all, it allows only pawns to be promoted to queens. Honestly, it isn't that hard to produce a chess game that plays by the rules. SPOC also loves to play P-k3 as its first move (1. e3 as White, 1. e6 as Black). This is safe, but has no other virtue. It also loves to give check. For

instance, I took Black in the following game: 1. e3 e5 2. d4 ed4 3. ed4 d5 (A position that more commonly arises from 1. e4 e6 2. d4 d5 3. ed5 ed5) 4. Bb5+ (SPOC gives check!) c6 5. Qe2+ (This reminds me of the chess aphorism, "Always give check—it might be mate." This is akin to saying "Always look at your shoes while you walk—you might see a quarter.") Be7 6. Ba5 Nf6 7. Bf4 0-0 8. Nf3 Re8 9. 0-0 Bg4. Black stands better, but SPOC has done nothing horrible. Chess Partner would have given something away by now.

SPOC also has the annoying habit of going back to MS-DOS when a game is over. You must keep rerunning SPOC every time you want to play a new game. You also cannot set up positions, retract moves, or play another human using your PC as a \$2,500 chess set. Chess Partner allows this last feature, but I don't feel it's worth mentioning in their sales literature.

SPOC also has no opening book to draw upon. This was a disappointment to

me in both games. Since PCs are endowed with disk drives, chess games should use them. Standard openings could be stored, or famous games from the past could be put on the program diskette for the user to play through. This would take advantage of one of the PC's important features. It has

**S**INCE PCS  
are endowed with disk  
drives, chess games  
should use them.

a mass storage device, and chess is a game with an immense literature that can easily be put on diskettes.

Only SPOC provides you with the option of making a hard copy of your game, so I decided to play a game and record it on a printer. Here is what came out:

1 e2-e3  
2 e7-e5  
3 d2-d4  
4 e5xd4  
5 e3xd4  
6 d7-d5

Not only did SPOC use an entire line for each player's move, it invented a new system of chess notation. It gave each "half-move" its own number. Thus White makes all the odd-numbered moves, and Black makes all the even-numbered ones. Lest you think this is a wonderful idea, let me point out that moves have been numbered the same way for 200 years so that move one encompasses both White's move and Black's reply. This is a sensible standard, and if the authors had ever read any chess text, they might have encountered it.

SPOC offers another feature lacking in Chess Partner. Having used up all the paper on the printer, I turned my attention to SPOC's ability to save games. The instructions explain how to do this. You must use a separate diskette, but not just any diskette. SPOC has its own scheme for saving games. Since you must use MS-DOS to run SPOC, no doubt you will be lulled into believing the way it saves games has something to do with MS-DOS

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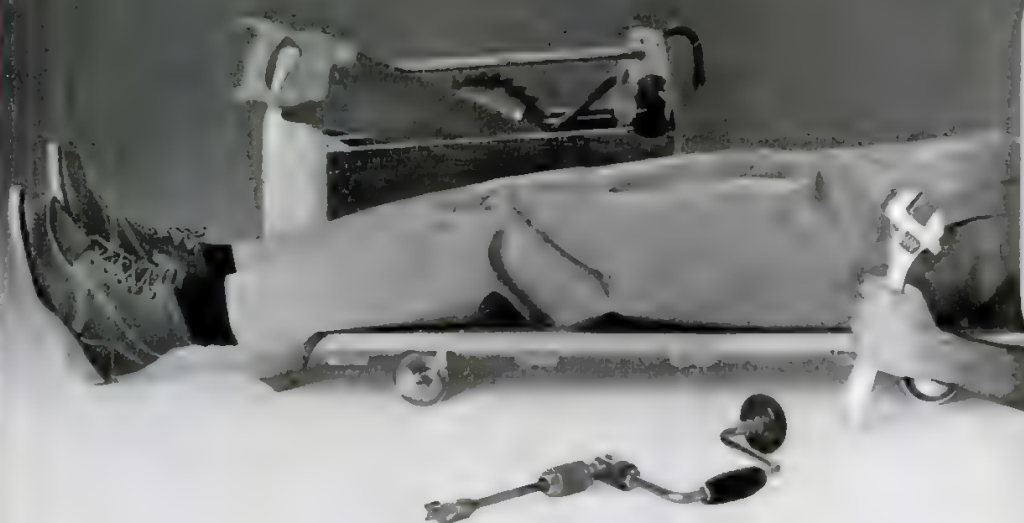
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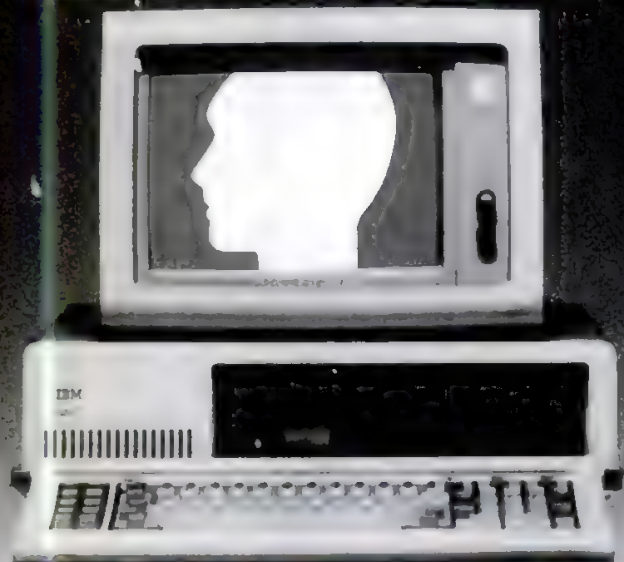
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files. Wrong. SPOC has a better idea. If the diskette you use has anything else on it, it won't when SPOC is finished with it. Not only that, but SPOC is able to save the magnificent number of eight games per diskette. This certainly allows for expansion. A 40-move chess game can be saved

**I**F THE  
diskette you use has  
anything else on it, it  
won't when SPOC is  
finished with it.

in 30 to 240 bytes, depending on how clever you want to be. This is less than 2K for even the simplest of schemes. A tremendous use of a 160K diskette that can ordinarily hold as much as 320K of information.

At least SPOC can use a black and white monitor. That's something. I tried it. A chess board appears with letters for the men. The letters are white (or green) on black for White and reversed for Black. Just try this on your PC. It is the most unreadable display I have ever seen. It is impossible to follow the game without a chess set, unless you know how to play blindfolded. This is especially irritating since the simplest, nongraphic display is more attractive.

R	N	B	Q	K	B	N	R
P	P	P	P	P	P	P	P

.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

P	P	P	P	P	P	P	P
R	N	B	Q	K	B	N	R

This very simple display is far more attractive than SPOC's.

Finally, SPOC is more expensive than Chess Partner. I cannot recommend it either. It has the basics in tow but lacks significant development features. Some other features are hard to use. Like Chess Partner it needs a lot more work. I would suggest buying several good chess books with your money and brushing up while waiting for something better to appear.

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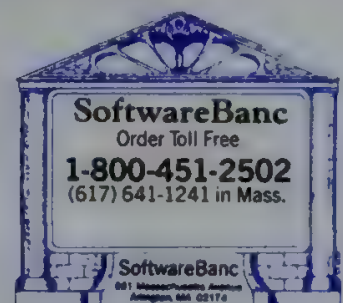
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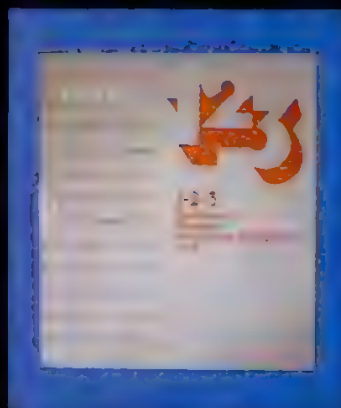
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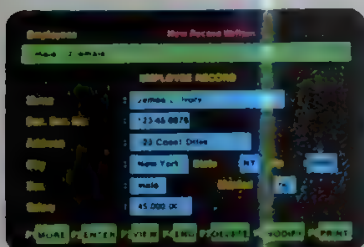
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# DATAEASE™

## The Complete System To Organize Your Business The Way You Want It

You can start using it in minutes, and within hours have a complete application.

### It Is Easy to Use:



- Fully menu driven to remove the guesswork.
- Full use of function keys with the assignments always displayed. All cursor movement and editing functions on the keyboard are supported.
- Provides full color support and screen style customization.

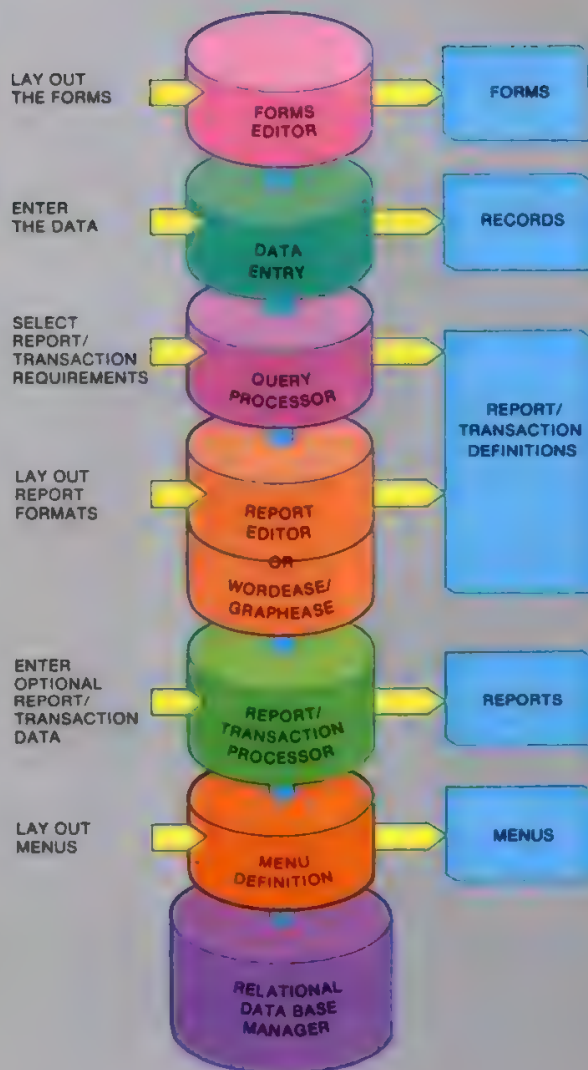
### System Features:

- A list of users can be kept, with passwords and security levels.
- The print style is customizable.
- Data can be interchanged with mainframe computers, other data bases or spreadsheet programs.
- Data base back-up and restore functions are integrated to reduce errors.

### System Requirements:

- Available on IBM-PC, DEC Rainbow, TI Professional, Victor 9000, and other 16 bit computers.
- Supports floppy or hard disk drives.
- Supports all popular printers.

### It Provides A Complete Range of Features:



- Lay out your forms on the screen. Define data-entry fields anywhere by answering simple questions. Revise the forms any time without losing data.
- Easy, fast and accurate way to fill-in the forms and enter, view or revise records.
- The reports or transactions requirements are defined in the English-like query language by answering simple questions. Select records any number of ways, combine any number of forms per report, perform calculations, get totals, sub-totals, or statistical summary. For complete transaction processing, delete, modify or enter records.
- Reports are automatically formatted in several ways, or specify your own format using the Report Editor.
- To format a report complete with text, data, and graphs; use the optional WORDEASE™ word-processor or the GRAPHEASE™ graphics facility.
- Display or print the report output, or take it to your spreadsheet, word processing, or graphics programs.
- Organize the access to your forms and reports by setting up your own menu.
- The underlying Relational Data Base Manager provides efficient storage and retrieval of records. It uses B-tree indices for efficient accessing of records, and cache memory to retain the most recently used disk sectors to reduce disk access by 50 percent.

### These are Some of the DATAEASE Applications:

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Personnel Management  
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Mailing List

Accounting  
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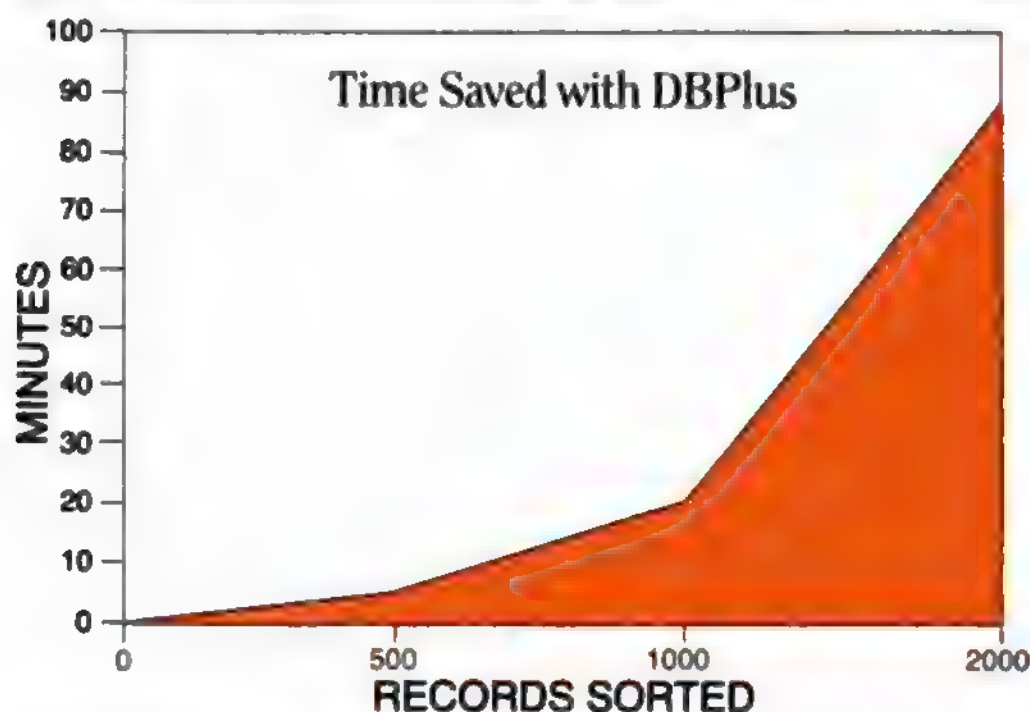


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- **Compress/Decompress**
- **Transform**

DBPlus™ is designed to free you from the chore of typing or memorizing a new language. In most cases all you have to do is move the cursor to the next menu item and press return!

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You can now modify the structure of any data file by adding, deleting, and modifying fields without any programming knowledge.

DBPlus™ can also create a new file which is compatible with WordStar/MailMerge.™

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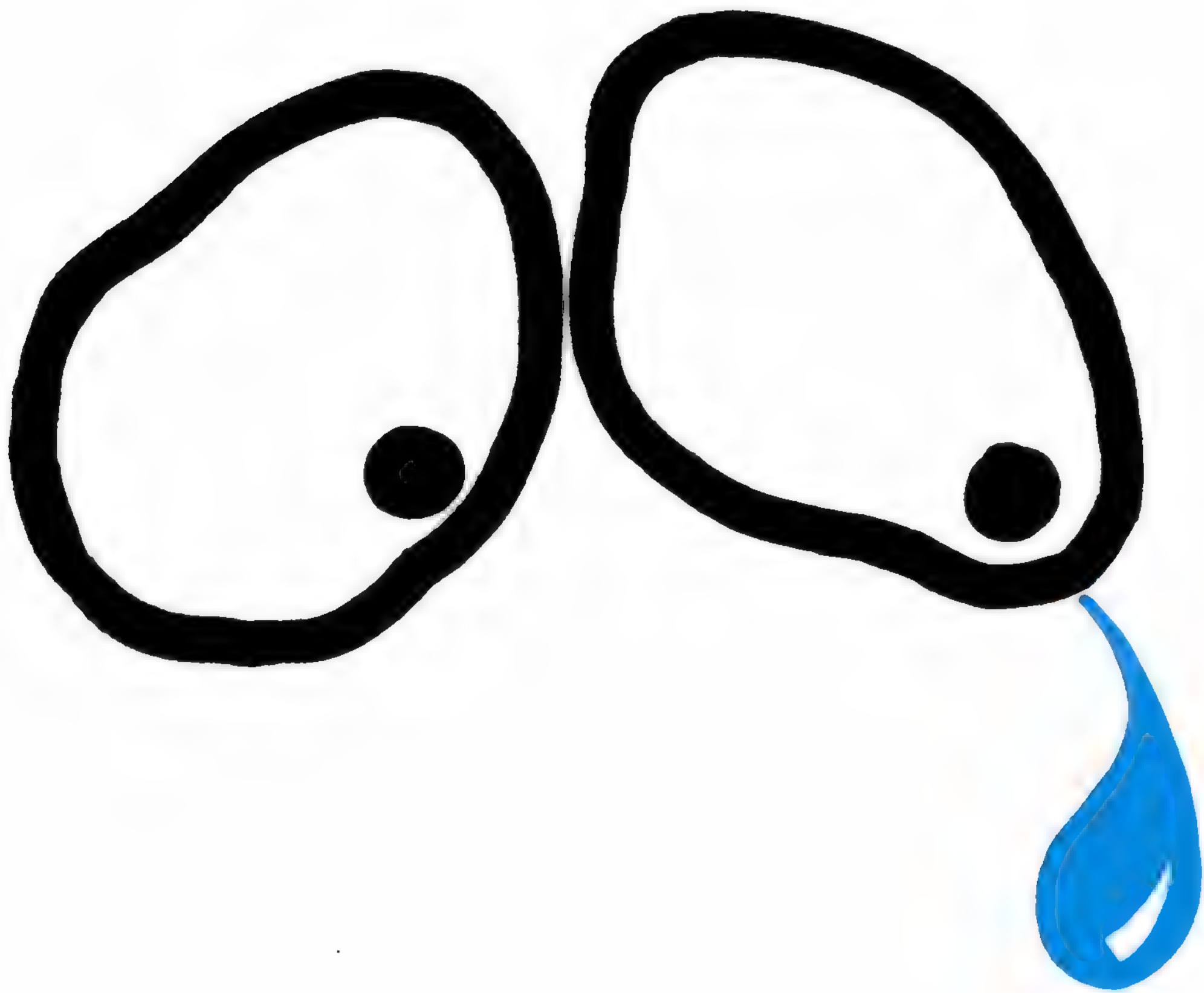
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## **...AND EASY TO LEARN.**

Learning to use the commands is Easy. Because our manuals are written in English, not engineering. And there's toll-free subscription PhoneSupport™. With a genuine

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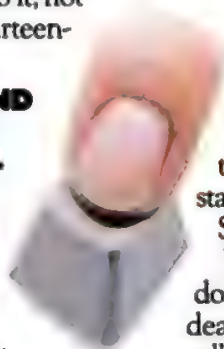
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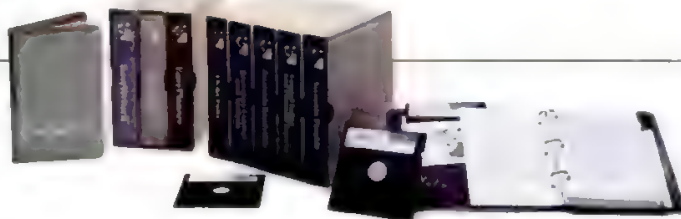
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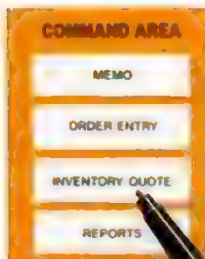
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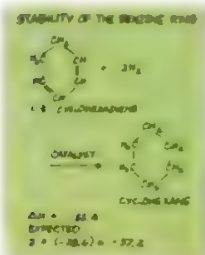
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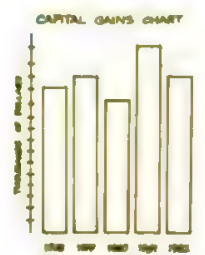
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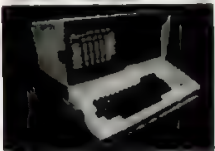
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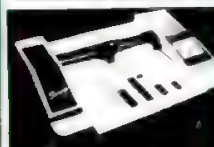
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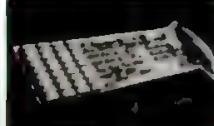
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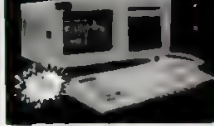
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**Requires:** PC-DOS 1.1 or 2.0, one disk  
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---

**YOU CAN**  
*display two versions of  
your word processor—  
one for notes, the other  
for current text.*

---

Better still, you can move data from one partition to another. You can stick a spreadsheet into a report, move a deduction from your calendar to your tax form, copy a phone number from a database into

a letter, or switch from your communications package to WordStar to read a recently downloaded file without having to wade through mysterious Greek and European language characters.

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### How Do I Crash Thee?

Enough fantasy. Is Memory/Shift really sharper than a Ginsu knife and more powerful than a Saturn rocket, or is it the latest pet rock?

Well, let's say you really want to get your money's worth out of Memory/Shift. You've got your word processor running in one partition, your database in another, your spreadsheet in a third, your calendar in a fourth, and your communications package in a fifth. While the boss goes out for a coffee break, you switch to partition six to play *Dioxin Detoxer*, an adventure game with a thrill at every turn. Unfortunately, it doesn't understand your command, "nuke New Jersey," and goes dead on you. You press every combination of keys you can think of, but there is absolutely no response. Drive B begins making funny noises. The only way out is to turn off the machine and restart it.

You have just witnessed a disaster of a magnitude unimaginable before Memory/Shift: a six-bagger crash, wiping out every bit of data that's in the machine and very likely messing up unclosed disk files as well.

Well, that's only theoretical, right? A

cautionary illustration? Let's put it this way: The on/off switch on my PC got more use the night I tried Memory/Shift than in any recent month I can remember.

### Shifty Moves

The first thing you do with Memory/Shift is use one of its batch files to copy DOS onto it. Unfortunately, neither the manual nor any on-screen message bothers to explain that the DOS disk you're supposed to put into drive B must be the complete IBM-DOS disk, or at least one including SYS.COM and all the system files on it.

This minor omission can cause major problems. When reconfiguring the Memory/Shift disk in a change from DOS 1.1 to 2.0, the batch files can easily create a mixed system—that is, one that has one version of COMMAND.COM and a different version of the system files. This can wreak utter havoc—or merely cause an apparently inexplicable system hang-up. All versions of the manual point out that you can upgrade your disk from 1.1 to 2.0. Only the later ones mention that you cannot return it to 1.1 ever again.

Once it's got the system files on it, the Memory/Shift disk is ready to go. You load your system with any other programs that will remain resident, such as disk emulators, print spoolers, and hard disk drivers. Then you put the Memory/Shift disk in drive A and type MS.

The screen gives you a message from Memory/Shift telling you that the program is copyrighted and that it was written by

**THE ON/OFF  
switch on my PC got  
more use the night I  
tried Memory/Shift than  
in any recent month I  
can remember.**

someone named Jonathan L. C. More. It also indicates how much memory is available in each partition. In this case, you get the default setting: two partitions, one with 64K (or, I believe, 76K in DOS 2.0) and the other with whatever's left of mem-



ory. After you respond to the DOS time and date prompts, Partition 1 shows you the familiar A>, and you may do whatever it is you normally do upon seeing it.

When you feel the urge to open Partition 2, you hit either Alt-2 or Alt-Esc. The screen instantly switches, and an inverse-video line in the lower right corner of the screen tells you exactly which partition you're in and how much memory is assigned to it. That line disappears with your first keystroke, which will probably be an Enter in response to time and date prompts. Though the documentation doesn't say so, Memory/Shift is able to pick up the current system time, and now Partition 2 is ready to do your bidding. To switch back, you hit Alt-1 or Alt-Esc. But if you've put any characters in front of a DOS prompt and you ask Memory/Shift to switch partitions, you have to hit Enter before anything will happen. Until you're used to it, it looks for all the world like a total system freezeup.

### Faults and Defaults

What if you want more than two partitions? Simple, if you're the careful sort. You may invoke the program by typing ms n=X, s=A,B,C where X represents the number of partitions you want and A,B,C and so on represent the memory size of each partition in K bytes. You must do this exactly right. An upper-case N or S will get you a "syntax error" message. If you specify too much memory, you'll get a "memory allocation" error. And if you happen to omit the memory size specifications, guessing that there must be some built-in defaults, guess again. The machine goes into a dead hang that can be overcome only by turning it off and starting up again.

The other way to change the defaults is to run an installation program. That has a few zingers in store, too. The manual says the installation program's default setting is the same as the bootup: two partitions with a minimum of 64K each. This seems to be true—sometimes.

When I ran the program with my disk emulator in place, that default is the one I got. When I rebooted to take advantage of my PC's 576K of memory, the default setting turned out to be eight partitions with 64K each. I accepted it; what I got was a setup with seven 64K partitions and an eighth with 110K—a total of 558K.

I tried again, refusing the default. This

time the installation informed me that I had a 544K system and could install up to nine partitions. But when I went to install those partitions, I was told I had 558K of

## *T*HERE'S NO way of finding out how Memory/Shift has been configured without actually invoking it.

"allocatable memory"—the amount the default chose to use.

I'm still not sure what's going on here. The folks at North American Business Systems say Memory/Shift is set up to "see" only 512K, but that it can set up partitions adding up to more than that because the partitions share a single copy of DOS. That sounds fishy to me. If it's true, why did the program tell me I had a 544K machine instead of 512K? And why did North American warn me that a 128K system won't give two 64K partitions? Ah, well, I suppose there are some mysteries we are destined never to solve.

This, incidentally, was an "improved" installation program. I won't bore you with the crazy math the first one came up with.

The installation program lets you change the key combination that selects each partition. If you have a graphics card, you can choose each partition's text mode foreground and background colors, including "magneta" and "light magneta," and decide whether you'll save the full graphics display memory or only one page (the ramifications of which, once again, are almost totally undocumented). If you have two displays, you may choose which one will display each partition. You can disable disk checking, and you can reassign the keys used to change partitions, mark data, and move it. The manual claims that Alt-?-the Help key—is the only one that can't be reassigned. The more observant among us will note that F1 and F2 can't either. And the more irritable will complain that there's no way of finding out how Memory/Shift has been configured without actually invoking it.

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Once you've got Memory/Shift working, the Alt-? combination brings a modicum of help via a tiny inverse-video "pop-up" menu in the lower right corner of the screen. The menu tells you which partition you're in, how much memory is allocated to it, and which disk drive is the current default. Option 1 tells you which Memory/Shift key combinations do what. Option 2 lets you "set display adapter parameters." With a monochrome adapter, it lets blinking characters do just that. For some inexplicable reason, Memory/Shift turns off the blink attribute unless you tell it otherwise.

With a color monitor, you get to change the foreground, background, and border colors as well. Unfortunately, on the IBM color display we had running for at least 15 seconds at a time, DOS insisted on blinking every time we did anything with it. Given the Parity Error 2s we kept getting, we never got far enough to discover what would happen with a real application program.

### Shifting Bytes

"Just what is the 3200-byte buffer?" asks one of the manual's headings. To the utter amazement of those who expected a polishing cloth for a school of piranhas, it turns out to be what you use to transfer data within the same partition or from one partition to another.

**GIVEN THE  
Parity Error 2s we kept  
getting, we never got far  
enough to discover what  
would happen with a  
real application  
program.**

To put information into this infamous 3200-byte buffer, you press Alt and the Gray Plus (+) key. A pop-up menu informs you that the Gray Plus key appends data to the buffer and that the Gray Minus (-) key clears the buffer out before data is acquired. After making the choice, you define a block of data by mov-

ing the cursor around to mark the upper left and lower right corners of an imaginary rectangle on the screen.

Memory/Shift takes command during this operation, and its box-shaped cursor can be made to go anywhere on the screen, regardless of whether the program would normally allow this. The arrow keys on the cursor pad do what you expect, except at the edges of the screen, where they bring you back to the opposite end of the same screen line. The four keys at the corners of the cursor pad—Home, End, Pg Up and Pg Dn—take you to the corresponding corners of the screen.

After reaching the first of the two defining corners, you press the space bar. Then you move the cursor to the diagonally opposite corner and press the space bar again. Now the defined block is highlighted—though what this means depends on what's on the screen. Somehow the marked section of the screen will look different from the rest, but whether it will be in high-intensity, low-intensity, inverse video or exactly what depends on what's on the screen.

### Terminator with Extreme Prejudice

Another pop-up menu tells you to "Enter keystrokes to be appended to each line." This confusing instruction is the key to successful data transfer with Memory/Shift, but the documentation doesn't begin to explain it. Be it a carriage return or merely a space, some sort of line terminator is nearly always required for successful data transfer.

When you dump data to the buffer, Memory/Shift reads it from the screen. This means it is totally ignorant of important invisible characters such as carriage returns. Nor can it read control characters: to Memory/Shift, >C is two characters—a caret and a C. This can fool you badly when using a program that uses the caret convention for displaying, but not storing, control characters.

Furthermore, Memory/Shift observes particular (and, needless to say, undocumented) conventions in the way it reads the screen. It ignores blanks at the end of any line, and it ignores all blank lines. That's why it's absolutely imperative to use terminator characters; otherwise the last item in each line will run smack up against the first item in the next. In the case of a program like WordStar, a blank



usually does the trick, since a carriage return would inhibit reforming paragraphs. If you're moving entries into a database or spreadsheet, you've got to consider what kinds of commands should follow each line.

Once you've typed in the terminator

**A**ND THOUGH the manual breathes not a word of the fact, you can transfer only ASCII and extended ASCII characters.

character or characters you want, you hit the illogical F1 to put them at the end of each line or F2 at the beginning. A copy of the marked block goes into the buffer, and you're back to your program. If you want to tack more data onto what's in the buffer, you have to go through the whole process again. Memory/Shift's data-capture mode only works one screen at a time. And though the manual breathes not a word of the fact, you can transfer only ASCII and extended ASCII characters. According to North American, the data-transfer mode doesn't work with noncharacter graphics. Whether this means it will crash is left to our imaginations.

Since your screens rarely have every position filled with data, the 3200-byte buffer amounts to a little over two screens. If you try to overflow the buffer by appending too much data to it, you usually discover that Memory/Shift has highlighted only the amount of data it has room for. Once you hit the space bar to dump the data, you sometimes get a message to the effect that the remaining highlighted text didn't get in. Sometimes you don't. And one time I got that message along with a spectacular light show as the text on my screen oscillated between high intensity and low in a charmingly artistic but apparently random way.

#### Depositing Data

Once you get where you want the data in the buffer to go, all you do is press Alt and Gray Minus. This maneuver doesn't

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clear the buffer, so you can use its contents again and again if necessary.

When you call data from the buffer, Memory/Shift brings it in serially, as if it were typed. This is none too speedy. It can take nearly a minute and a half for WordStar to process a full buffer of text. Frighteningly inaccurate screens appeared dur-

ing the process, but everything cleared up the instant data transfer was complete. But if you happen to be transferring to the middle of a WordStar file and you've forgotten to change the program from the otype to the insert mode, you'll watch in horror as the incoming data wipes out everything below it.

Data transfer presents other sticky problems because of incompatibilities between programs. Moving a wide spreadsheet into a program like WordStar will have to be done one screen at a time and

**F**RIGHTENINGLY inaccurate screens appeared during the process, but everything cleared up the instant data transfer was complete.

requires exceptionally careful planning. Furthermore, many programs can't handle certain characters the PC is capable of producing. Trying to move inadmissible data into a program that won't accept it can lead to weird results.

Your spreadsheet, for example, may not be too happy about getting text where it expects to see numbers and may well interpret some of those letters as commands, much to your chagrin. WordStar took SuperCalc's vertical line character and converted it into a 3 by ignoring the high bit. PeachText's paragraph-marker character simply disappeared when it was ported over to WordStar. A program with less sophisticated error trapping may burp and die when given data it can't handle—taking all the other partitions down with it like a house of cards.

### Disk Follies

Diskettes present a special series of challenges to Memory/Shift. If you're using a program like WordStar, which swaps overlays into memory from disk, you have to remember to have the program disk in the proper drive. Fortunately, Memory/Shift is smart enough to remember which disk you had in the drive when last you used it—and demand that you put it back.

It keeps track by giving each disk a label—actually the filename of an empty and hidden file. In DOS 2.0 it's the 11 character DOS "volume label," but if you haven't christened the disk, Memory/Shift asks you to and lets you do it. In DOS 1.1,

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you get only eight characters to play with, and *Memory/Shift* adds the extension <L> without telling you.

The <L> is an odd choice, since angle brackets are illegal file name characters in DOS 2.0. Though DOS 2.0 won't let you enter such a label, it doesn't seem to mind seeing it. Still, considering the new DOS manual's warning to give a new monicker to all files with newly-illegal characters in the file name, you have to hope you won't be playing with a time bomb when using old *Memory/Shift*-labeled DOS disks with DOS 2.0.

Of course, a disk copy of a given disk would carry the same label as the original, and *Memory/Shift* wouldn't be able to catch the problems if you used the copy by mistake. A more likely problem could be created by using one disk in more than one partition, which the program is quite willing to let you do.

The manual does warn you not to use the same file in multiple partitions, because two different versions of it could wreak havoc with the disk's file allocation table. Fine, but if you're running two versions of *WordStar* or another program that creates a temporary file with a standard name (*WORKING.TXT*, say, or *EDBACK-UP.\$\$\$*), you could conceivably modify that file in two different partitions without even realizing it. If that happened, the file could be irretrievably corrupted. When I tried it, *WordStar* was smart enough to recognize that something was rotten in the state of *MEMSHIFT. \$\$\$*, announced a "Fatal Error F28: Close Failure," dumped

one attempt I made at getting a program to run was unsuccessful. DOS couldn't find the program I wanted from the disk. It didn't have such problems before *Memory/Shift* was installed.

### Let Me Count The Ways

Crashes, I hasten to reiterate, are the

real bane of a program like this. If the crash is severe enough—and it usually is—you will have to turn off the machine and wipe out whatever is in memory in the other partitions. You may well discover that you have open files on some of the other disks—or worse.

It's possible to exit a partition while the

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**A** PROGRAM  
*may burp and die when  
given data it can't  
handle—taking all the  
other partitions down  
with it like a house of  
cards.*

me back to DOS, and saved my original text. Other programs may not be so accommodating.

I did not check this program out at length on an XT. Suffice it to say that the

program there is writing a file to disk. If that file gets written only partially, and a crash in another partition keeps you from going back to close the file, you can probably say goodbye to it. If the ruined file is an index to a random file, you'll have a very tough time indeed getting at your data. And if you're particularly unfortu-

nate—for example, if you clobbered a file directory before it was fully rewritten—you could lose the whole disk.

I deliberately courted a couple of these disasters, so I know they can happen. North American Business Systems says it's addressing the problem in versions currently being tested. In the meantime, it

wouldn't be a terrible idea to have a copy of the file-recovering Norton Utilities around just in case.

### Boot Hill

If a hang-up hasn't turned the system deaf to the pleas of the keyboard, banging on Ctrl-Alt-Del will reboot a single partition without harming the others. To reboot the entire system, you use Left Shift-Ctrl-

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**C**RASHES,  
*I hasten to reiterate, are  
the real bane of a  
program like this.*

Del. If any other partitions are open, you then receive the warning: "Danger: other tasks active" and must confirm that you really want to reboot the whole machine.

In theory this helps you to avoid the danger of leaving partitions with potentially open disk files. In practice, many problems won't let you reboot the current partition, so it's time for Boot Hill—turning the machine off and on again. The partial reboot feature itself has hung up my system on at least two occasions. Still worse, it's possible to reboot a single partition with a version of DOS that you didn't begin with. Since Memory/Shift retains only one version in memory, this could lead to no end of problems later.

### Irreconcilable Differences

Memory/Shift happens to be incompatible with a wide variety of programs. The documentation lists three that Memory/Shift won't consort with: Hayes Smartcom II, WordVision, and ProKey. I tried them and it's true. North American claims it's working with Hayes and the WordVision folks to correct the problem, but the ProKey incompatibility can't be rectified. This is a shame, because I sorely missed being able to use ProKey while testing this program.

But there's plenty of other software that won't run with Memory/Shift and may even cause a crash. Programs that don't stick to strict PC-DOS conventions are the prime suspects, but standard DOS

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programs that are copy-protected are also a major problem. My spot-check showed that *Deadline* and *Asylum* (which use proprietary operating systems) refused to run, as did the copy-protected *Time Manager* (which would otherwise be a perfect program for this type of system) and *Visi-Word*. One of the Norton Utilities worked fine until I was finished with it and returned to DOS, at which point the system went into a dead hang. The *Memory/Shift* manual points out that *VisiCalc* may have trouble running from certain partitions. Leaving aside CP/M-86, p-System, and so on, it would be eminently safe to hazard a guess that there are plenty of other programs that won't run with *Memory/Shift*.

Copy-protection schemes fool *Memory/Shift*, but the program itself is copy-protected. Aside from the fact that you can't copy it to a hard disk, this is particularly annoying when you consider that you need a different copy for each version of DOS. True, once you load it, *Memory/Shift* remains resident in memory until you turn your machine off, so you can set your disk aside until your system crashes. And North American will sell you a backup—one per customer, please—for 14 bucks, which isn't all that avaricious. But the company can hardly complain about all those copy-protected programs that sneak around standard DOS and knock *Memory/Shift* down for the count.

### Abundant Confusion

The manual for *Memory/Shift* is truly abysmal. Avoiding important information in the name of "keeping things simple," it leaves the user high and dry with a few basic how-tos and almost no details or whys. Many major points are undocumented. Typographical errors assail the eye from every page in earlier versions.

**T**HE MANUAL  
is truly abysmal.

The new ones have actually been proof-read.

Confusion abounds. When you're through installing DOS on your *Memory/Shift* disk, you're told to turn your machine off and on—a truly irritating activity if you've got much memory at

all—when a three-key reboot would serve the same purpose. There is no frank discussion about the problems of using copy-protected software with *Memory/Shift*. But there is a glossary with such useful definitions as "EXECUTE KEY: Synonym for RETURN key" (perhaps they borrowed their machine from the Mafia) and

"MONOCHROME: Synonym for black and white" (a purist, the manual writer will defend against amber and green until his retina withers and dies). Despite an admonition to ask manufacturers of non-compatible programs to phone in with technical information, there's no phone number anywhere in the document.

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## I'm Not Lisa

To the people at North American Business Systems, *Memory/Shift* is clearly a big deal. They're marketing it hard, and they're hinting at powerful new additions in future releases. The company has a policy of supplying the first upgrade free when you return your warranty card, and

making subsequent updates available for \$14 each, which seems reasonable enough.

But the major problem with *Memory/Shift* is that it engenders absolutely no confidence, a particularly unsettling state of affairs for a program that has such a huge potential for disaster. Much of its

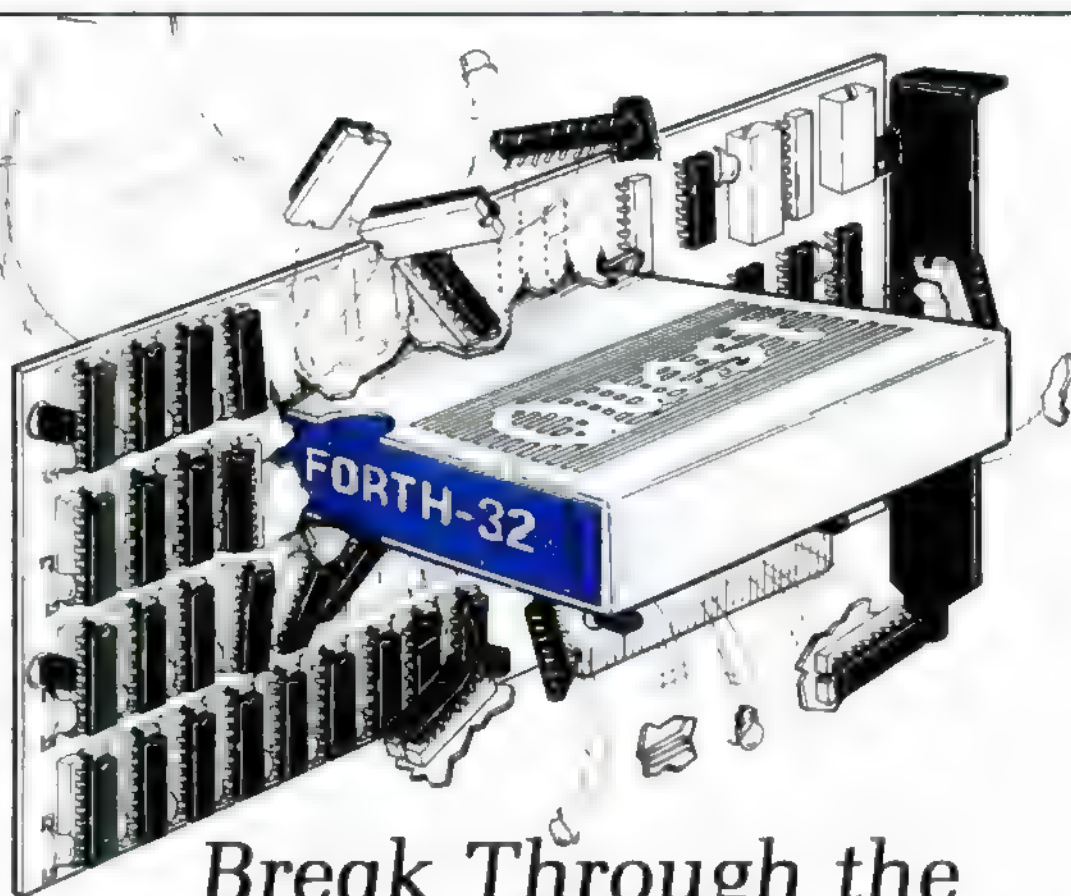
basic design shows thoughtfulness—but dozens of details betray the kind of hasty, careless, it's-good-enough attitude that helped bring down the American auto industry.

**P**ROCEED  
*with caution and make  
plenty of backups of  
your disks.*

When a program gives you three options—Y, N, and Enter—it shouldn't allow you to enter "Moe," "Larry," or "Joe." And a technical writer should know that anybody who needs to be told that a monitor is "The unit which looks like a TV tube and normally sits on top of the computer" has no business going anywhere near a program as fraught with peril as this one. And there should be no need for three different versions in a little over a month. If the program's ready, release it; if not, back to the compiler. With *Memory/Shift*, you never get the feeling that the program will consistently do what it's supposed to do, time and time again. It's precisely this feeling that separates the terrific software from the shelf-sitters.

*Memory/Shift* may well be biting off more than it can chew in its attempt to integrate wildly disparate varieties of software by monkeying with PC-DOS. Still, it does things nothing else I've seen can manage, and some moderately masochistic persons will probably be willing to take advantage of its potential and live with the warts. To them I offer the following advice: Try the program out with back-up copies of the software and data you're planning to use with it. Think of all the ways you can crash the system, and see what happens. If you do decide to use it, start slowly: Work with two or three partitions at first rather than the full complement. Proceed with caution and make plenty of backups of your disks.

*Memory/Shift* is not the Lisa, and it's not VisiOn. It's an interesting little program that could use a much better manual, a lot more testing, and a lot less hype. For \$99 you were expecting maybe the Goldberg Nine-Way Marvel, rube? /PC



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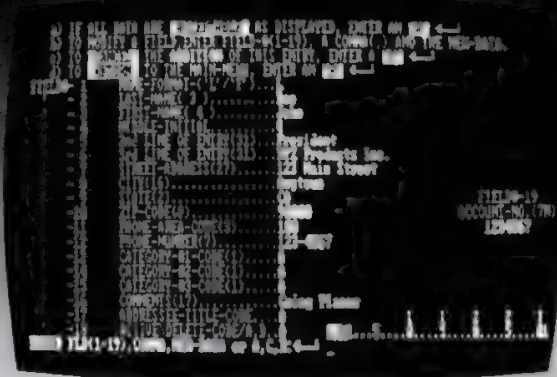
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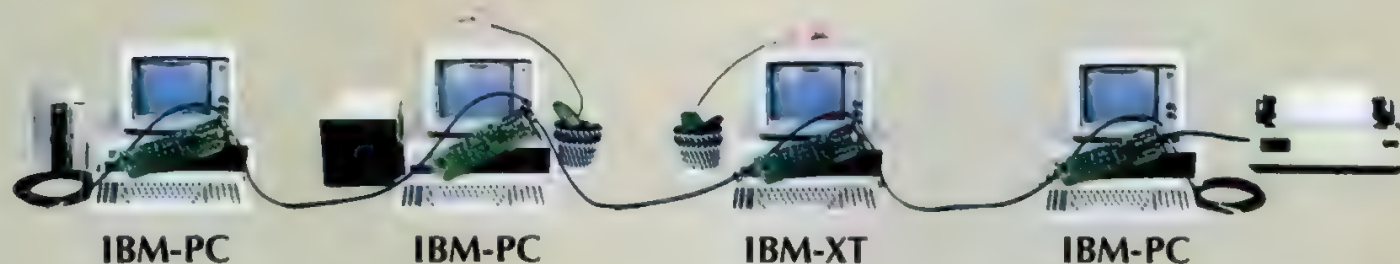


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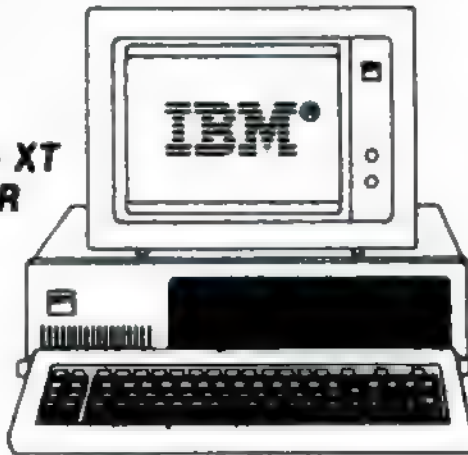
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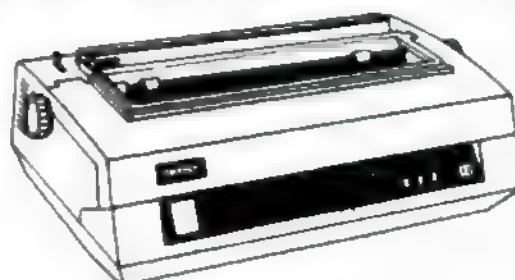
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CIRCLE 463 ON READER SERVICE CARD



*VisiCalc's creators now offer a program that lets engineers and scientists use a tool kit full of simultaneous equations.*

# The Versatile Variables Of TK!Solver

## TK!Solver

Software Arts, Inc.  
27 Mica Lane  
Wellesley, MA 02181  
(617) 237-4000

**List Price:** \$299; TK!SolverPacks for Mechanical Engineering and Financial Managing, \$100 each.

**Requires:** 96K, one disk drive.

CIRCLE 700 ON READER SERVICE CARD

VisiCalc was an innovative program. All by itself it probably sold more Apples than any other computer program extant. VisiCalc was also one of the first programs made available by IBM for the PC.

The people who designed VisiCalc spent a couple of years doing extensive research and development before finally releasing a product called TK!Solver, which is now available for the PC. In many ways TK!Solver may be considered an extension of the original VisiCalc concept. It is not a spreadsheet program, but rather an equation solver program for engineers, scientists, and other professionals.

Suppose you were designing a new machine. In this process you would frequently have to select between engineering advantages and manufacturing economies, necessary tradeoffs in the search for a cost-effective and useful machine. TK!Solver is designed to make that selec-

tion process as simple as possible.

When you first run TK!Solver the screen displays a blank variable sheet and rule sheet. The variable sheet will contain descriptions of the variables (input and output) used to construct the model. On the lower part of the screen the rule sheet describes the interactions between the variables.

Once you fill in the relationships, TK!Solver takes over. As in VisiCalc, you push the ! key to tell TK!Solver to solve the equations.

Let me present a rather involved example illustrating the capabilities of TK!Solver.

Suppose I am considering buying a house. I first set up a group of functions that describe the relationship between interest rates, duration of the mortgage, down payment, and monthly and total payments. Figure 1 shows how the variable, rule, and unit sheets might be set up. I pressed the ! key and TK!Solver found values for the output variables (see Figure 2). My monthly payments would be \$623.31.

I moved the cursor down to the interest rate line and changed 16.5 percent to 15.5 percent. I recalculated, and found that monthly payments had dropped to \$587.03 (see Figure 3). So far any spreadsheet could do these tasks, although TK!Solver makes it easier to set up the

functional relationships.

As a next step, I blanked out the total house price and instead asked: "if I can only afford to pay \$450 per month, with a down payment of \$20,000, what house can I afford?" Apparently, the house should cost about \$54,500 (see Figure 4).

Now, I want to consider a particular house, which costs \$65,000. What down payment would be required to meet my monthly payments of \$450? Apparently a \$30,504 down payment (see Figure 5).

Since \$30,000 is more money than I could pay all at once, I decided to raise the monthly payments to \$550; running the changed model (see Figure 6), I found the new down payment was only \$22,838.

If you aren't careful, it can be easy to specify the values of too many items, at which point the model no longer has a solution. Figure 7 shows the problem of an overspecified model. The > signs point to error conditions where TK!Solver found equations with no solutions.

When TK!Solver cannot solve equations directly, it uses a method called "iterative solution." An iterative solution is performed by guessing the correct value (in the case for interest rate) and then moving the value around until all of the equations are satisfied. The manual is a bit sketchy on what algorithms TK!Solver uses for the iteration method, but the final answers I received were correct.

You can see that the big advantage to TK!Solver is that variables are not fixed as input or output. This is unlike BASIC, where an equation, such as  $Y = 5 * X$ , works in only one direction; the BASIC instruction will take the value of X and multiply by 5 to get Y. Instead, in TK!Solver,  $Y = 5 * X$  means that X and Y are related by the fact that Y is 5 times as big as X. If you set X to 10, then Y is found to be 50. If you set Y to 15, then X must be 3.

As a last exercise, I set up a list of values for house prices, ranging from \$45,000 to \$65,000 (see Figure 8). The list named "houses" is associated with variable H in the mortgage model. By using the list recalculation feature of TK!Solver, you can actually watch the values on the screen go through the list. Figure 9 shows the set of results from the run of the list processing, showing the new monthly payments required given each house's total price.

The advantages of TK!Solver when compared with a spreadsheet are manifold. The most obvious advantage is that equations are treated the way people write them and think of them. An equation is fundamentally a relationship, not a directive to the computer to perform an operation. Further, equations use names for the variables, and units of measure. When you change the displayed unit of measure (if you wish to see annual instead of monthly payments, for example), the displayed values will change accordingly.

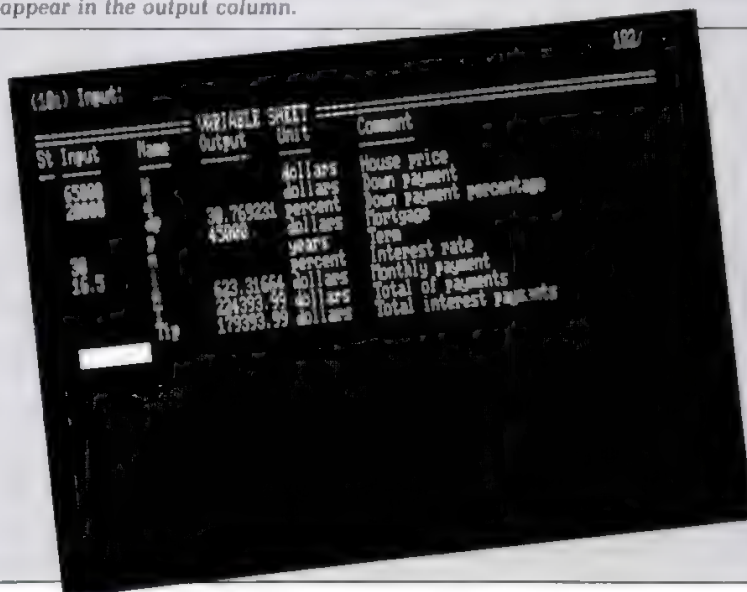
**A**N EQUATION is fundamentally a relationship, not a directive to the computer to perform an operation.

If you wish to see what happens as a variable changes, you can also define a list of values for TK!Solver. It will run through the selections, and display the results on the screen. TK!Solver also contains a rather crude plotting program which uses asterisks (\*) to display the values found during iteration.

Figure 1: The variable, rule, and unit sheets for the mortgage model to be run by TK!Solver.



Figure 2: After the ! key is pressed to solve the mortgage model, the values of unspecified variables appear in the output column.





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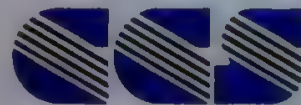
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CIRCLE 148 ON READER SERVICE CARD

Setting up a model is not a trivial task. You need to specify the variables, the relationships, and the units of measure. The people at Software Arts are hoping that engineers and scientists will work with them to create packages of models that can be loaded by TK!Solver. The first such package is a Mechanical Engineering TK!SolverPak, which I had the opportunity to play with. It contained a number of routines and a brief manual describing them. These included bending of an elastic beam, a cantilever analysis, cylindrical heat transfer, fluid flow in pipes, and a hydraulic system analysis/design program.

## THE PROGRAM comes with an enormous assortment of mathematical formulas.

The mechanical engineering models were quite complex, and they point up the usefulness of TK!Solver to a working engineer. It's easy enough to look up the formulas and plug in the appropriate values for a calculation. Doing this for a number of different parameters and changing the desired outputs is another matter entirely. For example, you solve the problem: given a pipe, find its heat transfer; then you turn around and try and figure out how to describe the pipe given a necessary rate of heat transfer. But that is another matter entirely. Commonly, this involves hours spent modifying and remodifying a program, or worse yet, bending over a calculator. TK!Solver excels in reducing the drudgery of those tasks.

The program comes with an enormous assortment of mathematical formulas (circular functions, net present value, polynomials, dot products, etc.) that can handle most common tasks. There is also a facility with which you can describe your own, more complex functions.

As far as solutions go, TK!Solver can iteratively solve most well-defined problems. It will perform direct solutions only on linear relationships or relationships involving defined inverse functions, such as arcsin. From a user's standpoint, the

Figure 3: The mortgage model is recalculated after the interest rate is reduced to 15.5 percent.

(10i) Input:

St Input	Name	Output	Unit	Comment
63000	House price	63000	dollars	House price
20000	Down payment	20000	dollars	Down payment
30	Term	30	years	Term
15.5	Interest rate	15.5	percent	Interest rate
	Monthly payment	507.83261	dollars	Monthly payment
	Total of payments	211361.74	dollars	Total of payments
	Total interest payments	166361.74	dollars	Total interest payments

Figure 4: TK!Solver finds the maximum price for a house that could be purchased with a down payment of \$20,000 and monthly payments of \$450.

(10i) Input:

St Input	Name	Output	Unit	Comment
20000	House price	54495.528	dollars	House price
30	Down payment	36.700259	percent	Down payment
15.5	Down payment percentage	34495.528	dollars	Down payment percentage
450	Term	30	years	Term
	Interest rate	15.5	percent	Interest rate
	Monthly payment	162000	dollars	Monthly payment
	Total of payments	127504.47	dollars	Total of payments
	Total interest payments			Total interest payments

Figure 5: The down payment is calculated for a \$65,000 house with \$450 monthly payments.

(11i) Input:

St Input	Name	Output	Unit	Comment
63000	House price	30594.472	dollars	House price
30	Down payment	46.929557	percent	Down payment
15.5	Down payment percentage	34495.528	dollars	Down payment percentage
450	Term	30	years	Term
	Interest rate	15.5	percent	Interest rate
	Monthly payment	162000	dollars	Monthly payment
	Total of payments	127504.47	dollars	Total of payments
	Total interest payments			Total interest payments

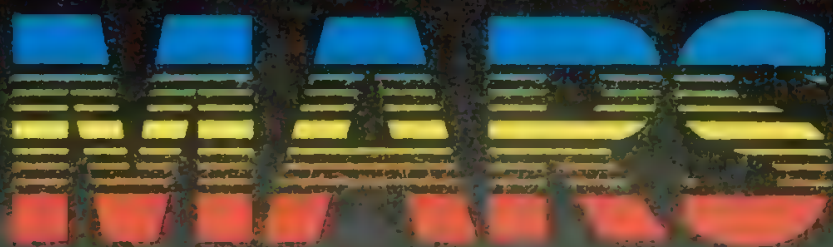
Figure 6: The down payment is less when the monthly payment is raised to \$550.

(11i) Input:

St Input	Name	Output	Unit	Comment
63000	House price	22830.799	dollars	House price
30	Down payment	35.136614	percent	Down payment
15.5	Down payment percentage	42161.201	dollars	Down payment percentage
550	Term	30	years	Term
	Interest rate	15.5	percent	Interest rate
	Monthly payment	190000	dollars	Monthly payment
	Total of payments	130030.80	dollars	Total of payments
	Total interest payments			Total interest payments



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Yet, for all its power and flexibility, MARS is easy to run. Menu-driven, with on-screen prompts at all critical points, it is decidedly user-friendly. Managers need not be computer experts to fully exploit the power of MARS, nor must they memorize long strings of complex commands. Every instruction is prompted. Installation and training costs are thus minimized, in fact possibly zeroed. A first-time MARS user with any computer experience can design and produce a hard-copy report within minutes.

## Expert Mode

Later, having become more familiar with the system, he can elect to use the "Expert Mode," bypassing the menu hierarchy altogether. In this streamlined operating mode the user interacts directly with the job matrix, watching commands being executed as they are keyed. Or, he can enter an entire sequence of commands and run the whole job automatically.

## Capacity

Consolidations, those notoriously inefficient and laborious "biggies," are handled by simply inputting departmental reports, either in their entirety or with selective eliminations—and running the job. Since a MARS report can contain more than 98,000 cells, a consolidation too large for the system is difficult to imagine.

MARS is quite simply several orders of magnitude beyond the now-familiar desktop spreadsheet systems.

## Availability

MARS is available on most systems with a minimum core memory of 64K, including CP/M-80, CP/M-86, MP/M, PC/DOS and MS/DOS.

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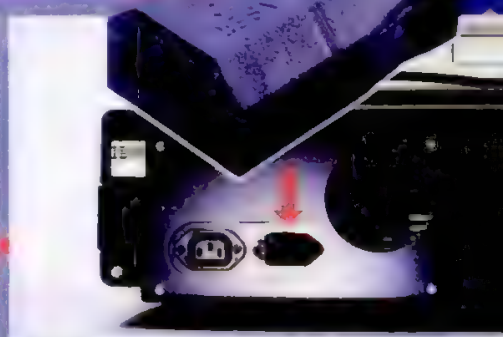
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CIRCLE 45 ON READER SERVICE CARD



Figure 7: A model cannot be solved if too many variables are specified in the input column. When this problem occurs, a > symbol appears in the far left column to indicate the unsolvable equations and irreconcilable variables.

(7c) Rule:

St Input	Name	VARIABLE Output	SHEET Unit	Comment
65000	H		dollars	House price
> 3000	P		dollars	Down payment
> 30	P		percent	Down payment percentage
> 15.5	P		dollars	Mortgage
> 300	P		years	Term
	P		percent	Interest rate
	P		dollars	Monthly payment
	P		dollars	Total of payments

5 Rule  
 \* H=Hd  
 \* P=Pd  
 \* R=1/(1-(1+i)^-n)  
 \* T=10n  
 \* Tip=T\*P

102/1

only differences between iterative and direct solution is that iterative solutions take a bit longer and allow room for error. If you're concerned about the extent of error possible in a calculation, you can examine the comparison tolerance for iterative solutions on TK!Solver's Globals Sheet.

I encountered a few problems with the program. When I ran the mortgage program I noticed that the value of 30 years in variable n had apparently turned into 29.999999. Even moving back to the cell and reentering the value had no effect on the number displayed.

As must be done in writing any computer program, TK!Solver's authors had to decide what precision value to use. For reasons of speed they used single precision (12 digits); the program has no provision for double-precision numbers or using the capabilities of an 8087 floating point processor.

One thing that electrical engineers will sorely miss is working with complex numbers. TK!Solver only can deal with real numbers, although polar notation can be used if you specify all of the complex arithmetic as rules. Some of the mechanical engineering problems in the TK!SolverPak were done in this manner, resulting in a loss of the model's comprehensibility.

Finally, TK!Solver has the same bugs that VisiCalc has due to the copy protec-

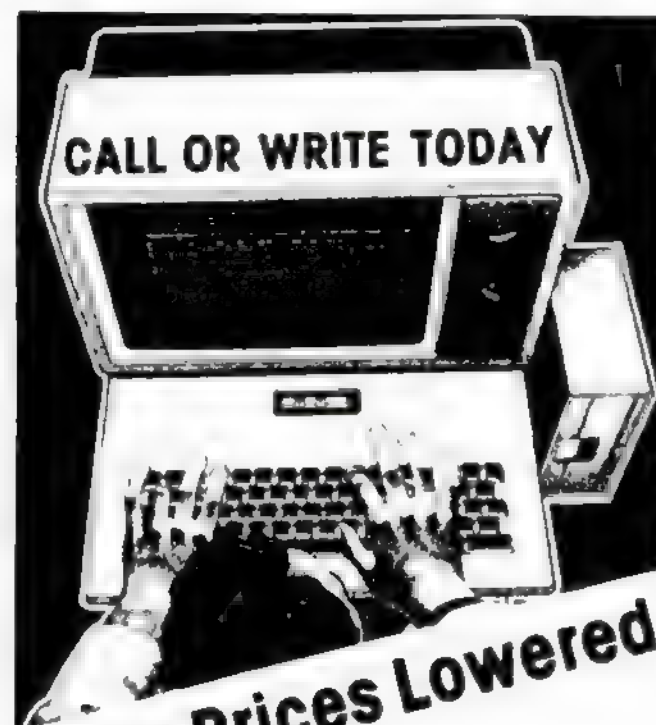
tion scheme used by Software Arts. Pressing the Break key after you exit from the program can have disastrous effects. I suggest rebooting upon completion, even though the program returns to PC-DOS.

The user interface to TK!Solver is almost identical to VisiCalc. The primary difference lies in the need to manipulate a number of sheets. This is not a problem thanks to the windowing they use.

**T**HE ONLY differences between iterative and direct solution is that iterative solutions take a bit longer and allow room for error.

There are no formatting commands. Cells are displayed as numbers with optional decimal point, or, if necessary, in scientific notation. Similarly, you can't really generate a business report, but that function is not in the spirit of the program.

It is very surprising that a more



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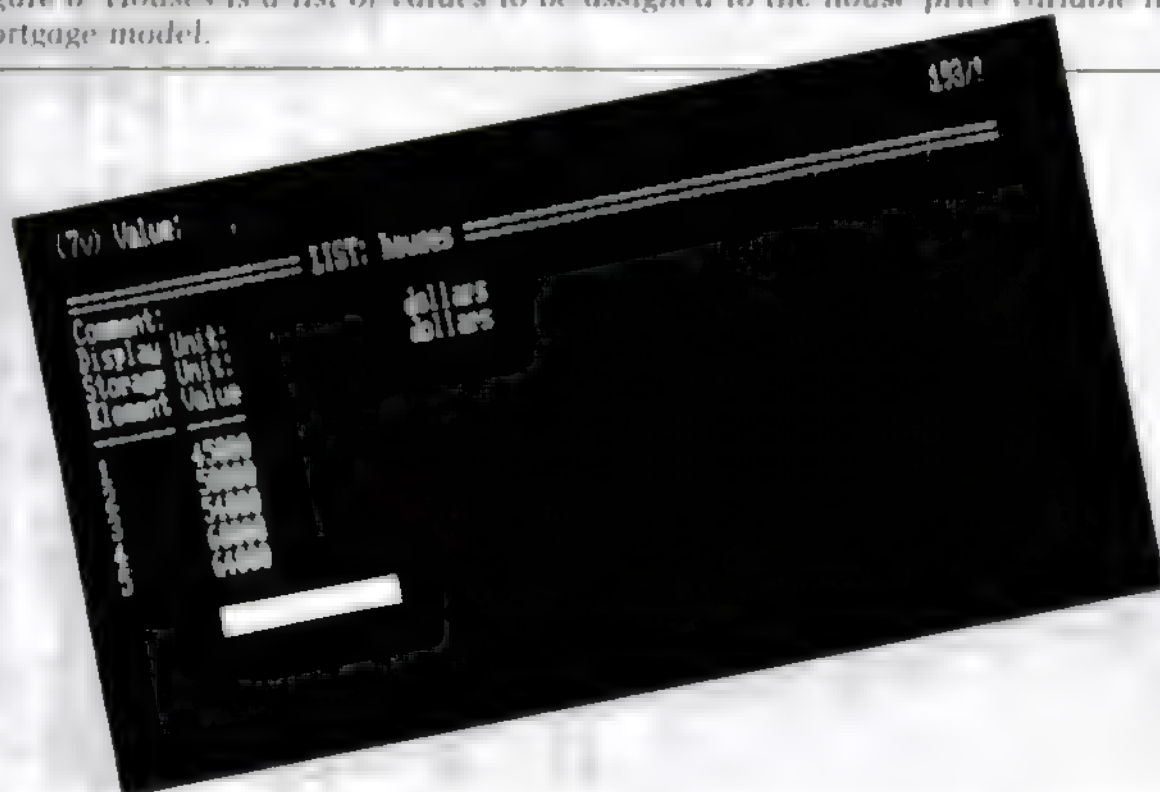
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CIRCLE 184 ON READER SERVICE CARD



Figure 8 Houses is a list of values to be assigned to the house price variable in the mortgage model.



advanced user interface was not used. You still have the / key command, which leaves you looking at a menu that consists of only seven letters—abbreviations that may or may not make sense. As with VisiCalc, error messages are usually no more than a beep from the computer. Except for left and right cursor motion, the PC's function keys are not used in formula or text editing, leaving you with backspace delete as the only editing command.

In fact, all of the menus were single letter menus of the VisiCalc variety, with no way to get a more useful summary of avail-

able choices. In the same vein, I spent some 20 minutes trying to figure out why I had received an error message while trying to create the figures for this article. I was informed of the error in this way: The computer beeped, and some > symbols appeared in the status column. Moving to the status column brought me this far from the informative message, "> error"!

In an attempt to increase the friendliness, TK!Solver does have Help messages. Pressing ? at any juncture places you in the general Help subroutine, which then asks you for a topic. There is no simple

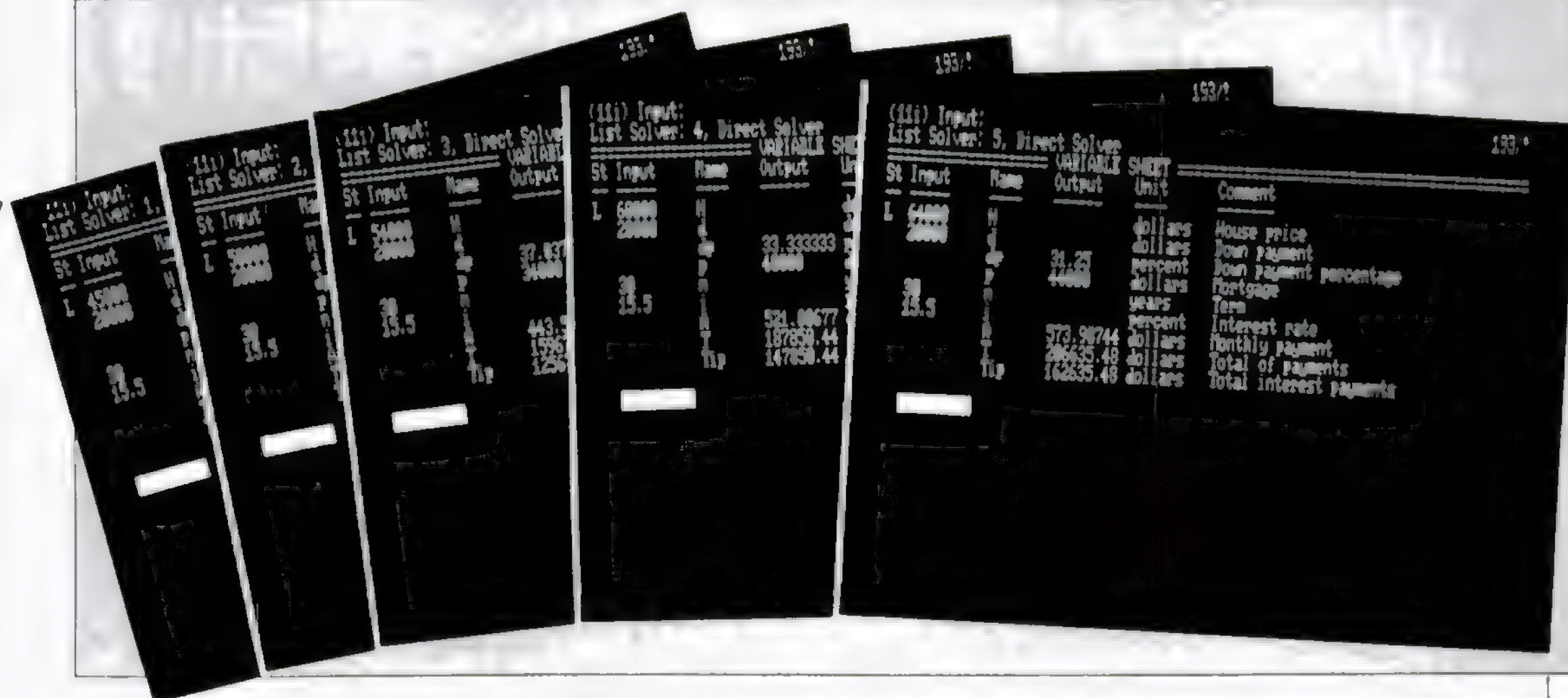
way to find out what a menu means. When you ask for Help with respect to a topic, the program will require about 30 seconds to display a wordy, not very useful, Help message (see Figure 10). In some cases the Help messages were totally unrelated to the Help item I had requested.

The user's manual is an attractive IBM-sized looseleaf with a number of useful illustrations. Some of its verbiage is a bit confusing, but the tutorial is a readable introduction, although insufficient for advanced use.

**AS WITH VisiCalc, error messages are usually no more than a beep from the computer.**

It looks as if the authors at Software Arts have taken lessons from IBM mainframe writers. Consider this example from page II-23: "The List Sheet contains a table of all lists created in the program. A list is a set of values assigned to positional element numbers." That's all there is to the

Figure 9. The variable sheet is automatically solved five times, giving results for each of the values on the list of house prices.



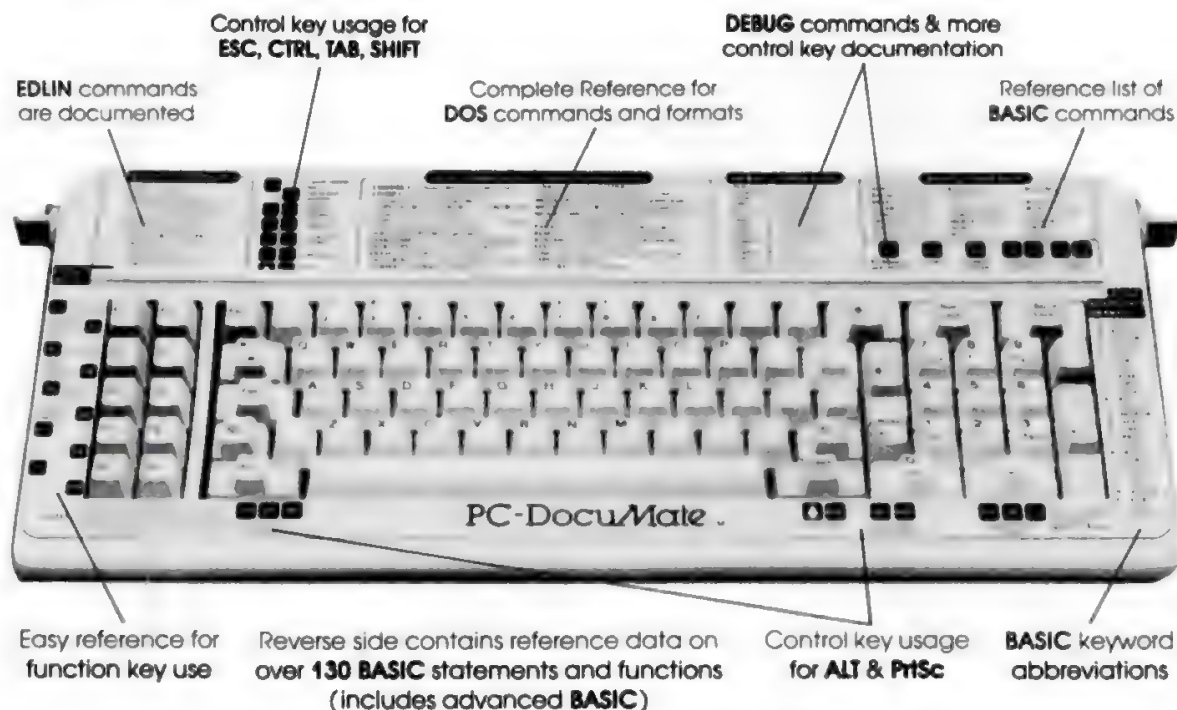


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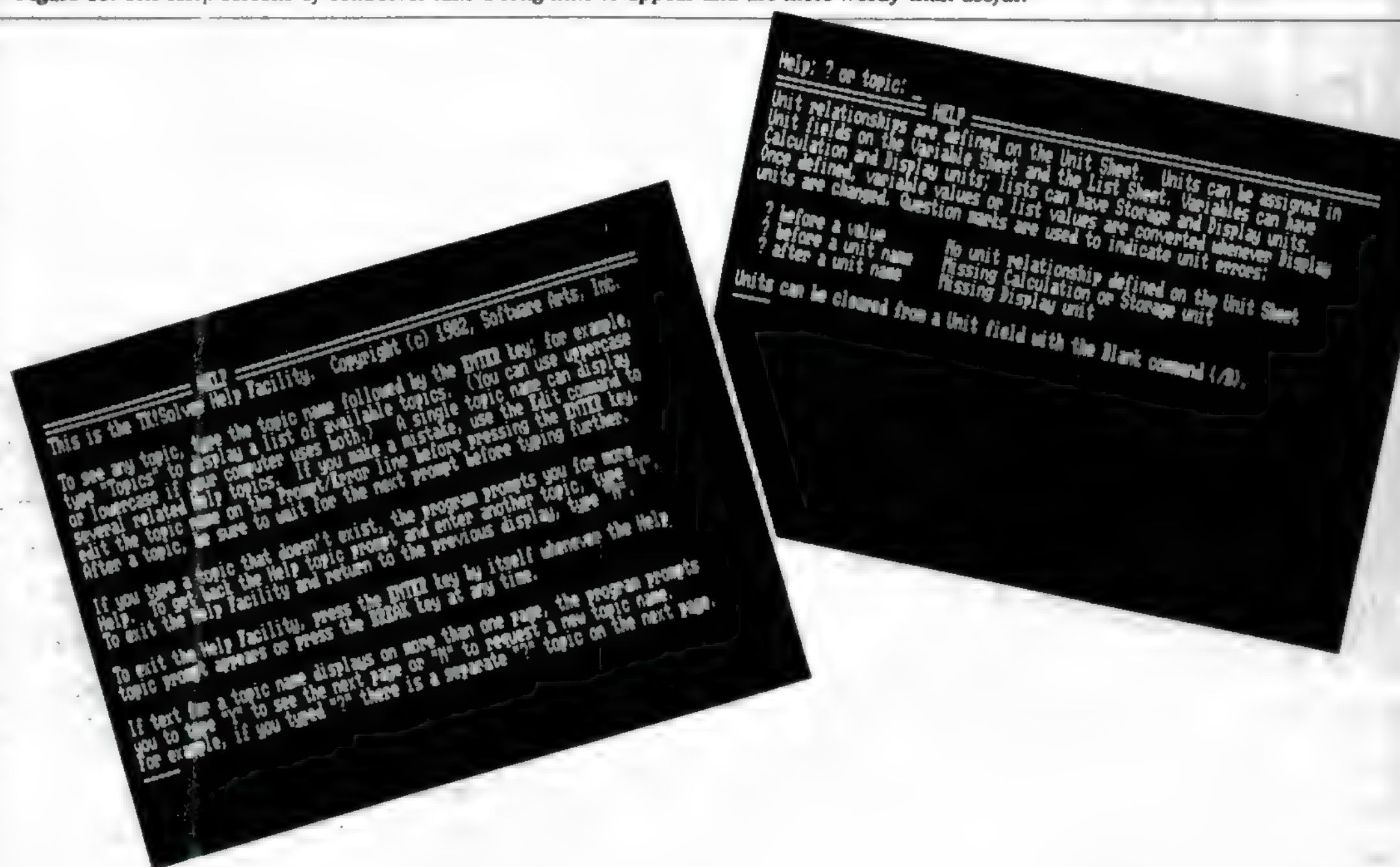
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Figure 10: The Help screens of TK!Solver take a long time to appear and are more wordy than useful.



discussion of lists. I still don't know how to get a printout of the results when using a list of values.

I estimate that if you are willing to spend on the order of 20 hours to read and reread the user's manual, it will begin to make sense. There's no escape from this effort. Even if you use a TK!SolverPak you will need to understand why errors occur and how to fix them, which means you will have to plow through the manual anyway.

I have two major complaints with TK!Solver. First, the program is copy protected. This means catastrophes can occur to the diskette's physical media and you cannot run TK!Solver off a hard disk. The program uses overlays, so it would speed up amazingly if it could be run under a RAM-disk or hard disk.

Since TK!Solver runs under PC-DOS, data files, at least, can be put on a hard disk and RAM-disk. I ran TK!Solver under PC-DOS 2.0 with no ill effects.

Secondly, the program has no graphics capabilities. One thing that scientists and

engineers have in common with business and home users is a desire to see results graphically. The character graphics supported by TK!Solver are inadequate for all but the crudest comparisons.

***If you are willing to spend 20 hours to read and reread the user's manual, it will begin to make sense.***

TK!Solver does allow you to send data to a DIF file, and some programs are available that convert DIF data into graphics. But this is not as interactive as a program that supports graphics internally.

My impression of TK!Solver has

changed radically since I began using it. At first I was distinctly disappointed with the program. It did not seem as innovative as I would have expected from a trailblazing company such as Software Arts.

On the other hand, after using it for a while, I found it to be a versatile tool. Engineers and scientists who have spent their time coaxing BASIC or VisiCalc to solve equations would be better off with TK!Solver. Even home users would find it has obvious advantages (as seen in the mortgage model in my example), although the program's cost may be harder to justify in a household budget.

My biggest disappointment is with the user interface. To operate their program you virtually have to sit with the user's manual on your lap, unless you use TK!Solver in your work constantly. The error messages and menus are pitiful. If you begin with a TK!SolverPak or a completed model, then this may not be such a problem. The final process of plugging numbers into a completed model is very simple, and quite rewarding. /PC



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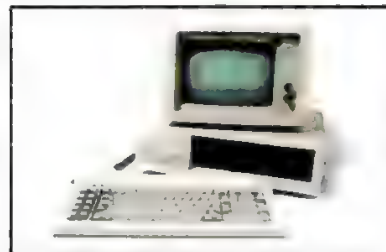
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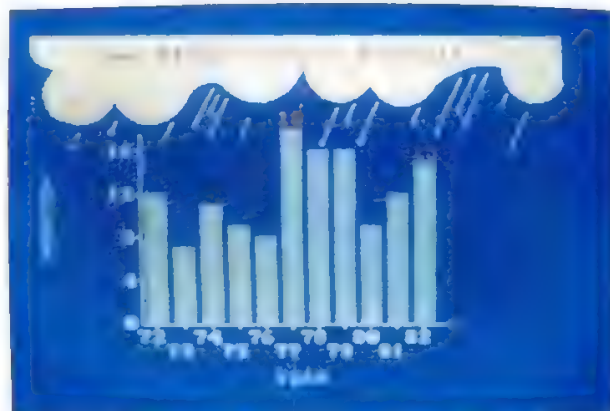
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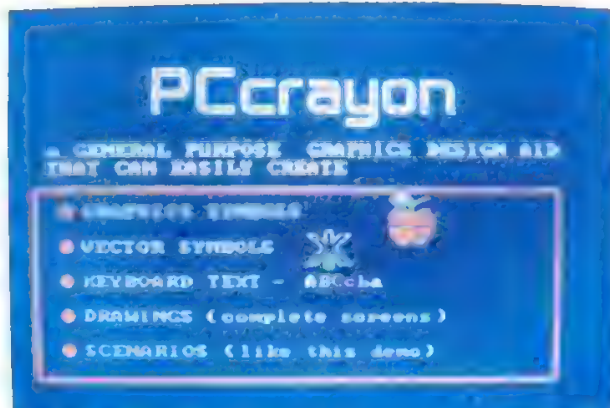
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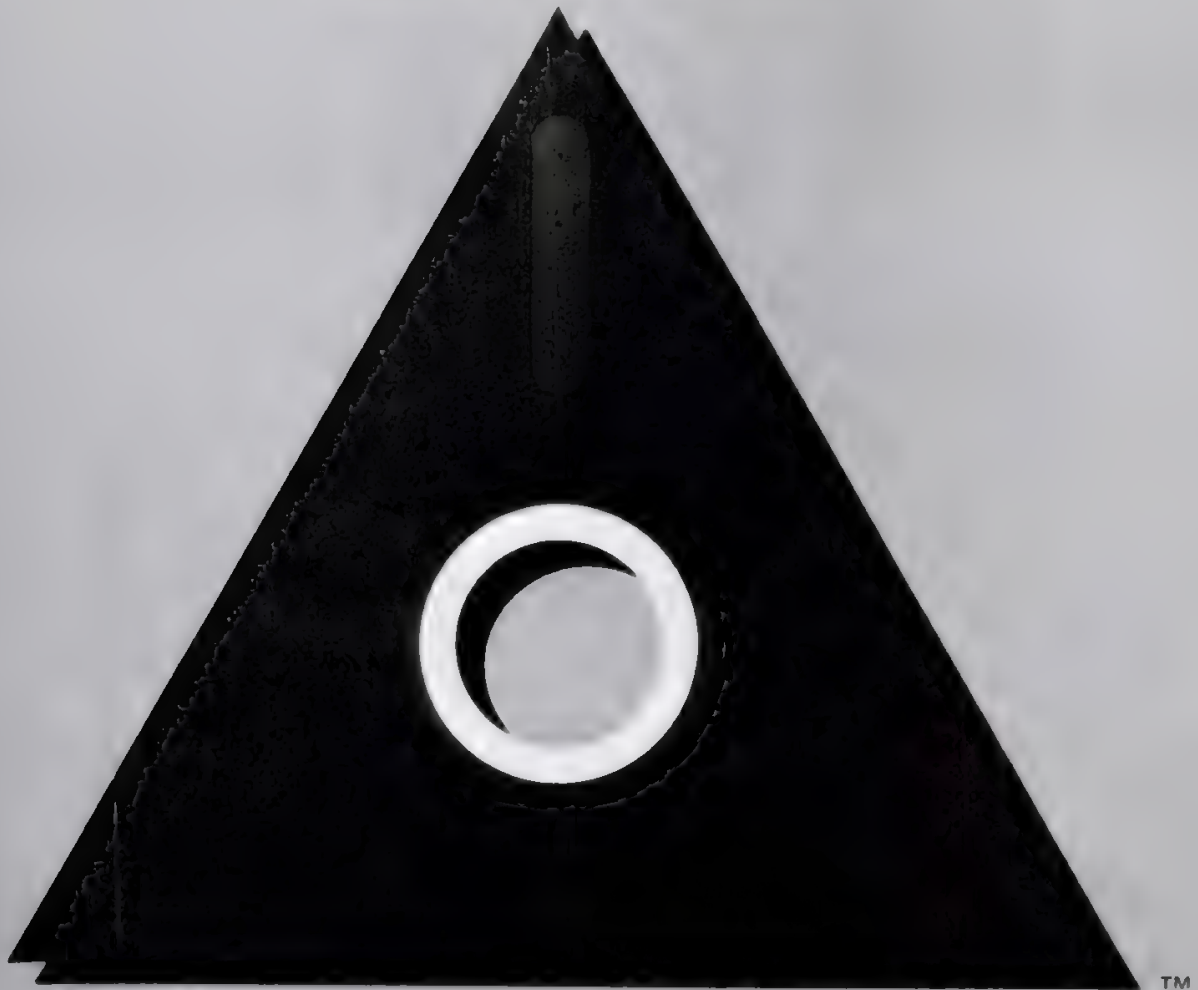


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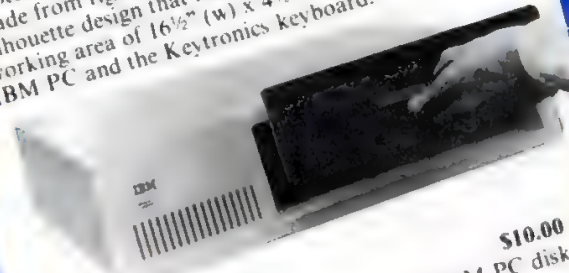
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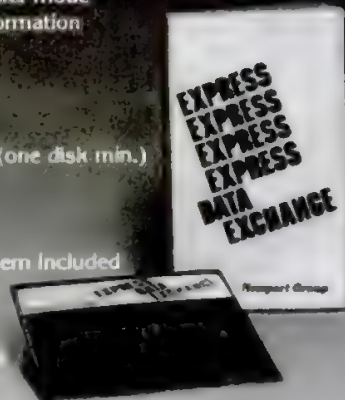
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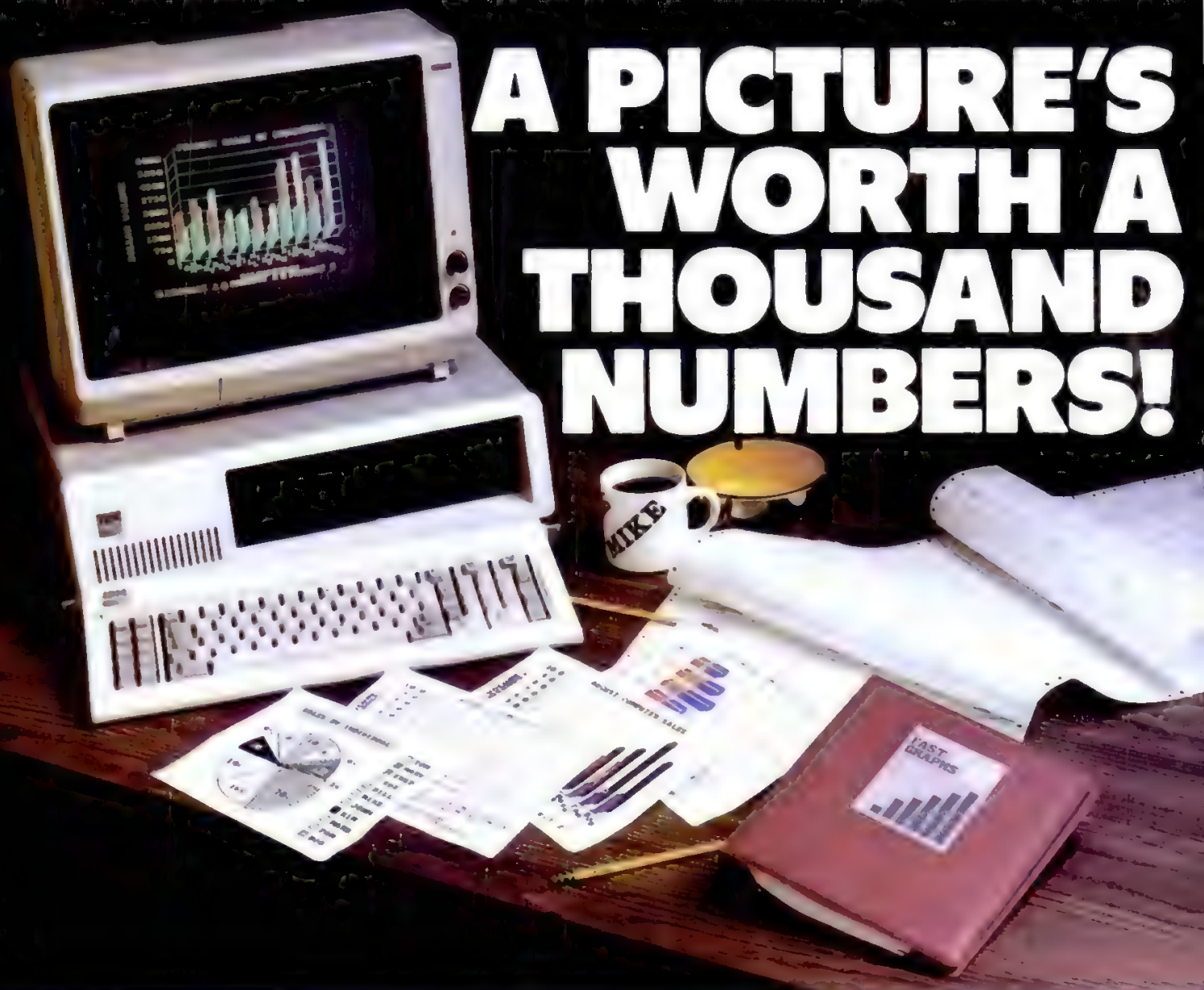
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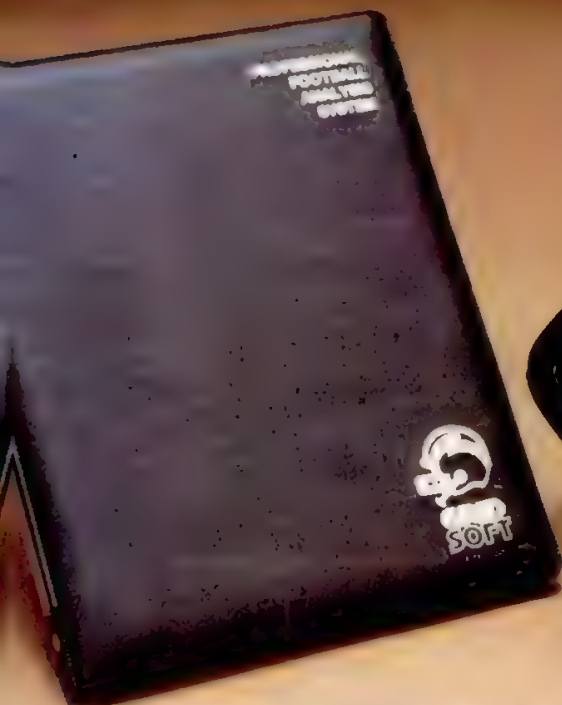
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1973	126	76	40	.683	136
1974	127	69	58	.543	130
1975	126	69	57	.548	130
1976	126	77	49	.611	136
1977	126	77	49	.611	136
1978	126	77	49	.611	136
1979	126	77	49	.611	136
1980	126	77	49	.611	136
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1982	126	77	49	.611	136
TOTAL	1260	762	498	.605	1360

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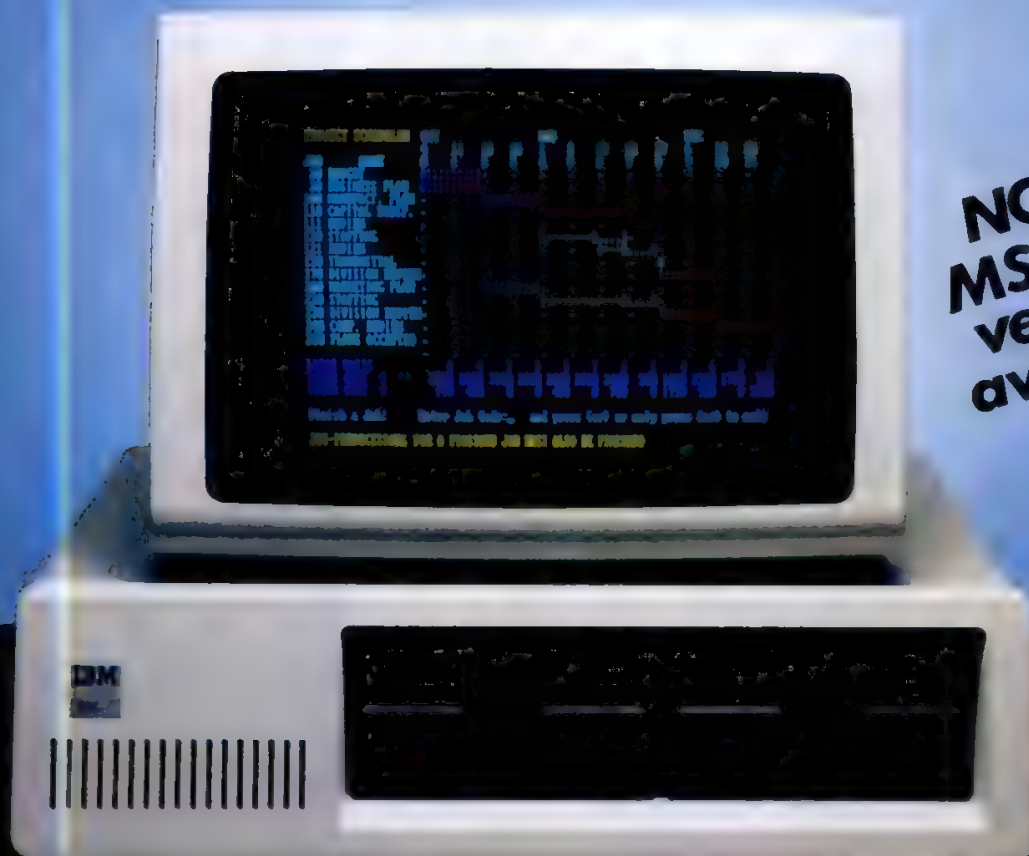
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*Once you teach your PC how to talk with the Echo Speech Synthesizer or the Speech Master, you might begin to notice its personality changing.*

# If I Only Had A Voice . . .

The popularity of this summer's hit movie *War Games*, which stars a talking computer, has people talking about speech synthesis. From the moment in *War Games* when high school student David Lightman turns on the speaker to show his girl friend Jennifer how his computer talks, the computer takes on human qualities.

But no mention of speech synthesis is made at all in the movie. The audience accepts quite naturally and quietly that a computer called Joshua can talk. After years of viewing them on television and in the movies most of us accept talking computers as fact. Actually, it's only quite recently that speech synthesis has come

out of the laboratory and experimental stages. Two speech synthesizers, now available to the consumer at a reasonable price, are reviewed here: the Echo Speech Synthesizer (General Purpose Unit) and the Speech Master.

Speech synthesis exploded onto the scene in the commercial marketplace in 1978 with the success of Texas Instruments' *Speak 'n Spell*. All of a sudden, people were aware that machines were talking for a very reasonable price.

Most people don't understand what speech synthesis is. Many think it works



*In the current hit movie, War Games, David Lightman (Matthew Broderick) shows his girl friend, Jennifer (Ally Sheedy), how his computer Joshua talks.*



something like a tape recorder, with all the words stored inside of the unit. In fact, it doesn't work like that at all.

Speech synthesis simply means the generation of speech by computers, such as the IBM PC and XT, completely on their own. What actually happens is that a computer models or mimics the complex process of uttering words—the sounds from our vocal cords, combined with the air and noise passing up our throats, through our mouths and past our lips. The actual speech is achieved in much the same way

as the output from the computer is printed following a PRINT statement. Instead of the words being printed, they are spoken (see Figure 1).

### Applications

A talking computer may be cute, but what can you do with it? Speech synthesis is more than a passing fad, a novelty, or something just for games. While synthesizing speech has been used for such esoteric and varied uses from communicating with dolphins to enhancing X-rated soft-

ware, its practical applications are diverse and impressive.

Some of the more common applications for speech synthesis at the present time include the following:

- Making computers accessible to blind people. Speech synthesis allows the blind to "read" computer output otherwise available only from the screen or printed copy. This is tied closely to word processing as well as computer programming for the blind. There are also programs that can read to the blind using speech synthesis.

- Mute people can now use an IBM PC, equipped with a speech synthesizer as a vehicle to speak.

- Education is one of the most widespread applications for speech synthesis. A talking computer can provide repetition, reinforcement, corrections, and encouragement, all in an atmosphere of fun.

- Business and industry are using speech synthesis for telephone touch-tone checking of inventory status and sales reports. Training programs lend themselves well to employees working with a talking computer. Industry is already using the sophisticated process of voice synthesis combined with voice recognition (i.e., the computer accepting verbal commands).

### Talking Screen Text Writer

One of the most exciting and successful educational programs making use of speech synthesis is taking place in Tempe, Arizona. Dr. Terri Rosegrant, a professor at Arizona State, has developed a word processing program for children, which uses speech synthesis.

The program, called Talking Screen Text Writer, is designed for ages 3 to 9, and has proven to be an effective learning tool for the learning disabled, educable retarded, and remedial readers. "Normal children tend to learn faster with this program, too," says Rosegrant.

Using an Echo Speech Synthesizer, Rosegrant's program allows a child to work at a comfortable, individual pace, while the computer repeats each letter and word typed. The child then sees and hears the words. Whatever a child types in can be saved on a disk and later reread, when the computer again says each word, flashing it on the screen.

Rosegrant has field-tested her program

**Echo Speech Synthesizer**  
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(805) 684-4593

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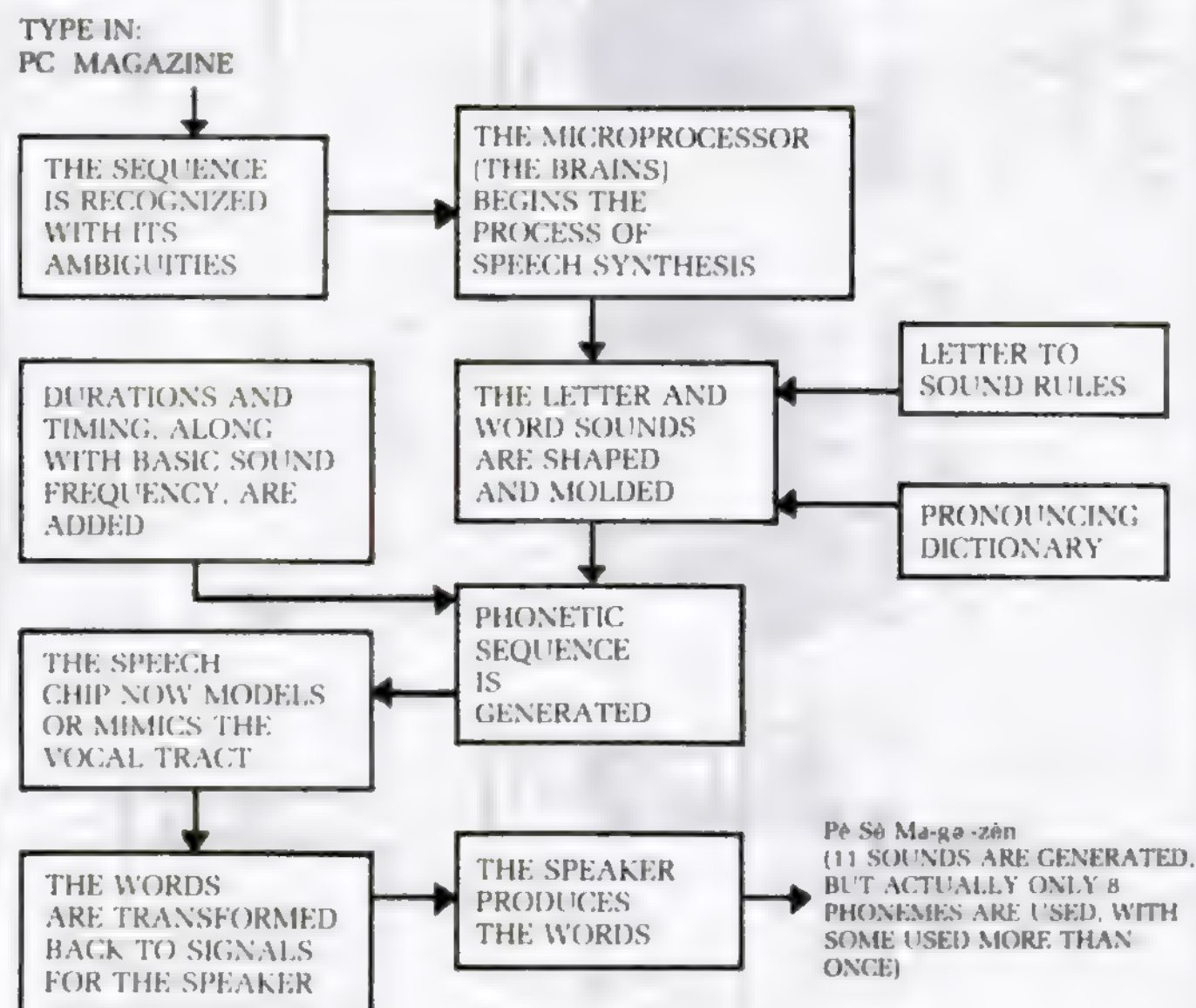
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Tecmar, Inc., Personal  
Computer Division  
6225 Cochran Rd.  
Cleveland, OH 44139  
(216) 349-0600

**List Price: \$395.00**

**Requires:** 64K RAM, two disk drives.

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Figure 1: How speech synthesis works (text to speech).





for a year on Apple computers, with much success. The program is currently being adapted to the IBM PC. Rosegrant co-wrote the program with Russell Cooper in assembled BASIC. Rosegrant firmly believes that "synthesized speech is absolutely required for good educational software."

---

## **S**YNTHESIZED *speech is absolutely required for good educational software.*

---

### **A Long Time Coming**

Speech synthesis can be traced back to the late 1700s when a Russian used acoustic resonators to synthesize vowel sounds. A hundred years later, Alexander Graham Bell produced a crudely constructed model of the vocal tract, which reproduced vowel sounds and even a few words.

It wasn't until the 1930s that Bell Laboratories invented one of the first speech synthesizers that could run on electricity. The device was called a Voice Operation Demonstrator (VODER). At that point, synthesized speech was expensive and had a long way to go before the talking contraptions could be operated at a reasonable cost and without a great deal of expertise.

For the past two decades the Department of Defense has been working on something called the VOCODER Project. This project digitizes, analyzes, compresses, and extracts speech parameters, which are transmitted over phone lines and then reconstructed. Many of the current speech synthesis techniques have come out of the VOCODER Project.

Today there are different ways to generate speech with a computer. Most of these procedures consume a great deal of memory, except for a process called Linear Predictive Coding (LPC). To understand how LPC works, it helps to take a brief look at other ways to synthesize speech.

One of the most effective alternatives is a process known as digitized speech. In this process, the size of speech signals is

measured every 25 milliseconds. Those measurements are saved in memory as digital numbers. Such speech is reproduced by converting the digital numbers back to signals, which are then sent to a speaker.

Digitized speech produces excellent quality speech, but it uses up incredible amounts of memory, 8000 bytes per second and up.

Two other methods of speech synthesis that reduce the memory requirements while still producing good quality speech are delta modulation and pulse code modulation. They use a technique similar to digitized speech, except that the process compresses speech. The memory drain is cut by half. The Supertalker board for the Apple and Fidelity Electronics' Chess Challenger games are examples of this approach.

In waveform compression, another process of generating speech, each different sound signal is saved only once and called up as needed. The sounds can then be modified to fit into the proper usage and sentence structure required.

The best example of waveform compression is National Semiconductor's Digtalker chip, which is being used for such products as the talking checkout counter at the grocery store.

And now we come back to LPC, which is quite different from the other methods, and uses very little memory. The other methods actually save the speech signal in digital memory, with varying degrees of compression. The signals are then "played back" again for speech.

Through LPC, instead of duplicating the speech signal, the human vocal tract is mathematically modeled. Sounds are then generated by a signal source, which is similar to the vocal chords. Language rules are programmed in so the generated sounds reproduce speech. The rest of the vocal tract is represented by a special type of mathematical filter that shapes sounds and gives them their various characteristics.

The secret to using such a small amount of memory lies in the phonetic encoding of words with LPC. English contains fewer than 50 basic phonemes (word sounds), from which all of our speech is derived.

By stringing phonemes together, any word in English (or any other language, for that matter) can be produced. So, in LPC

only the phonemes themselves need to be stored. They are used over and over again in several hundred different combinations for synthesized speech. Words are simply typed in on the keyboard and then spoken by the computer. The process is known as text-to-speech.

Because text-to-speech uses word sounds in so many different combinations, certain words need to be "misspelled" or, to put it more accurately, spelled phonetically, to make them sound right. It is because of the need for phonetic spelling that text-to-speech doesn't have the sound quality of other types of speech synthesis. Nor does it have the custom vocabularies known as fixed speech.

The advantages of LPC are twofold: Speech is intelligible and the amount of memory needed is as little as 150 bytes per second. One of the best benefits of LPC is that it allows unlimited speech. Just about any word goes, except for the ones that need to be spelled phonetically to get them to sound right.

Through LPC you can also have pre-encoded fixed speech, which is actually a custom vocabulary. A set list of words is actually stored in ROM or on a disk. While the number of words is usually limited, all of those words will come out sounding perfectly clear, without exception. The two programs reviewed here both offer fixed speech; the Speech Master has 147 words, while the Echo has close to 700 words.

---

## **D**IGITIZED *speech produces excellent quality speech, but it uses up incredible amounts of memory.*

---

The quality of fixed speech is much better than that of text-to-speech, but fixed speech uses more memory. Fixed speech through LPC saps about 150 to 200 bytes per word and needs to be stored somewhere. So the more words you have (or want) the more storage capacity (in ROM or on a disk) you need.

Text-to-speech is the most commonly

used option for personal computers because it uses so little memory and offers unlimited speech. It has, however, one considerable drawback: inferior sound quality.

Both Speech Master and Echo use text-to-speech and both sound somewhat machinelike or robotic. The Speech Master sounds much more like a machine than does Echo. Dr. Hisashi Wakita, president of the Santa Barbara Speech Technology Laboratory in California, feels that text-to-

speech lacks "naturalness." That naturalness is what makes the difference between feeling you're working with a machine and with something more personal. He explains that the machine-like voice is a result of limited memory environment, and with the cost of memory decreasing, better, more natural sounding speech synthesis will become available.

The fixed speech has a more human sound to it because the words are not constructed as they are needed. They are

pulled up from storage as encoded words. An interesting aside: Speech Master's fixed speech voice was male, and Echo's was female.

Both Echo and Speech Master can give your PC a voice. Both operate using the text-to-speech technology and both include the fixed-speech option. While similar in certain ways, their individual approaches are totally different. Speech Master comes on a board, which is installed in an expansion slot on the PC. The Echo is a separate, quite small box that is attached to the computer through a serial interface.

The differences don't stop there. Tecmar's Speech Master uses a VOTRAX SC 01 speech chip, while Street Electronics' Echo uses the Texas Instruments 5220 speech chip. The Speech Master costs twice as much as the Echo. The Echo has been around on the Apple for 3 years (under the name Echo II), so some refinement has taken place before this version was released.

## SPEECH

*Master's fixed speech voice was male, and Echo's was female.*

### Using the Speech Master

The Speech Master comes with a demo disk and a 22-page manual. Tecmar continues to release manuals that do a good job explaining installation but offer very little information in understandable English about actually using the product. For whatever reason, it provides two pages at the end of the manual for notes, followed by a "Product Comment Form."

Installing the Speech Master is easy, provided opening up your PC doesn't horrify you to begin with. However, once you close it back up you'll discover that the tiny round, black object on the back of the board is a speaker, which is totally inadequate.

What's even worse is that the speaker is mounted at the wrong end of the board. This means that the speaker is nowhere near the speaker openings at the front of

Figure 2: This is the list of fixed words for the Speech Master. Trying to put together different combinations of words for programs you write will be difficult because of the limited choice.

one	two	three	four
five	six	seven	eight
nine	ten	eleven	twelve
thirteen	fourteen	fifteen	sixteen
seventeen	eighteen	nineteen	twenty
thirty	forty	fifty	sixty
seventy	eighty	ninety	hundred
thousand	million	zero	a
b	c	d	e
f	g	h	i
j	k	l	m
n	o	p	q
r	s	t	u
v	w	x	y
z	again	ampere	and
at	cancel	case	cent
400Hz tone	80Hz tone	20ms silence	160ms silence
320ms silence	centi	check	comma
control	danger	degree	dollar
down	equal	error	feet
flow	fuel	gallon	go
gram	great	greater	have
high	higher	hour	in
inches	is	it	kilo
left	less	lesser	limit
low	lower	mark	meter
mile	milli	minus	minute
near	number	of	off
on	out	over	parenthesis
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your PC. Tecmar does provide the option of an RCA phono jack on the board. Plan to use an external speaker, because even with the volume control, the Speech Master board won't be able to generate enough sound from inside your PC.

I went to Radio Shack and bought an 8-ohm speaker/amplifier (which required a 9-volt battery) and a cable for less than \$20. The Speech Master manual does explain how to switch over to an external speaker: All you need to do is flip switch 7 open on SW1 and then position the speaker jumper to J2. Installing the speaker was effortless, but it required a trip to buy the speaker, reopening the PC, and additional expenses.

What the Speech Master manual doesn't do very well is explain how to use the Speech Master. The four sample programs in the manual are pitifully insufficient, to say the least. After some experimentation, and help from a technical expert, I was able to use Speech Master to get my PC talking.

The initial problem I had was with the demo disk. There wasn't any documentation with the demo disk and the manual provided no clues either. I later discovered that by listing the Talk program, I could compel it to explain how to run the Demo and Talk programs.

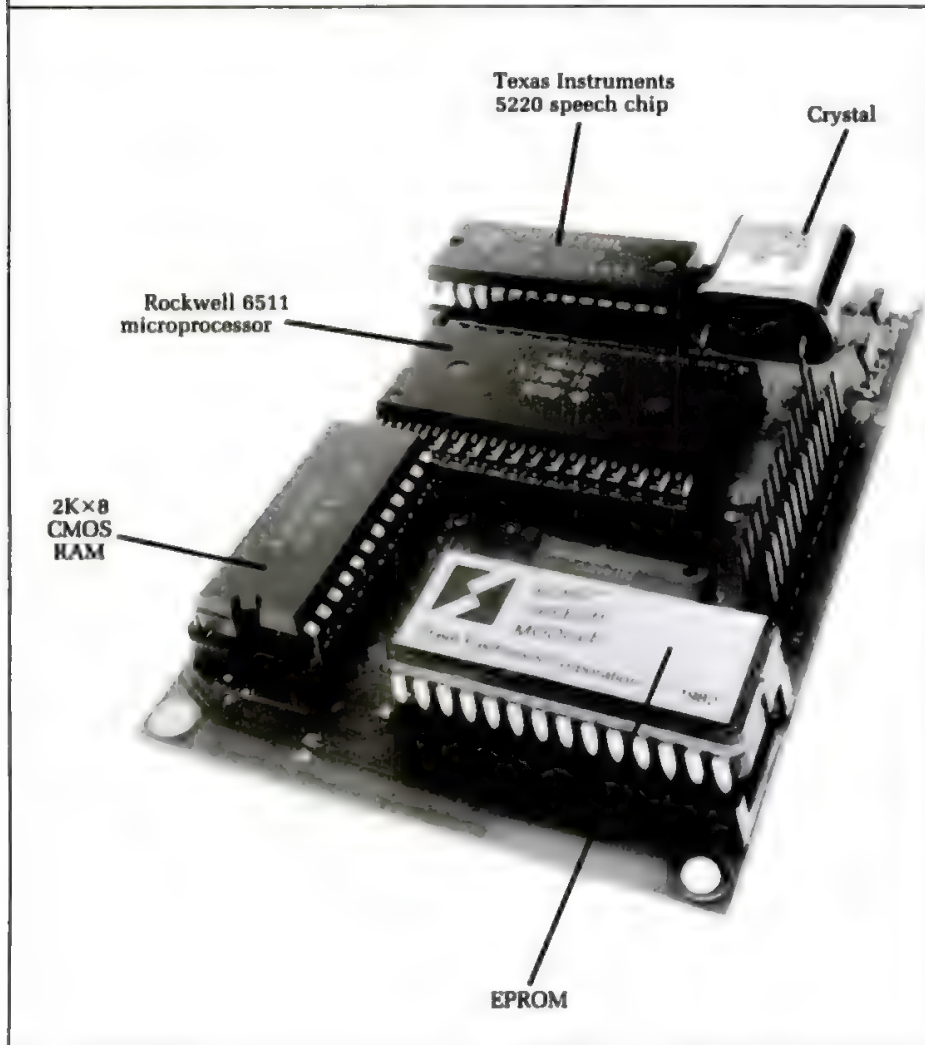
To run the Demo and Talk programs from the Speech Master support software

package follow these steps:

- 1) Load DOS 1.1
- 2) With the DEMO disk in the B Drive, type B:ENGLISH. This puts an overlay in RAM, which then allows the demo programs to work.
- 3) Then type in BASICA.
- 4) Remove DOS from the A Drive and replace it with the Tecmar Demo disk.
- 5) Then type LOAD\*DEMO.

**T**ECMAR  
*plans to release a model  
with more expansion  
modules of fixed speech  
to increase the number  
of custom words  
available.*

Figure 3: Echo's speech synthesis board. The crystal generates the clock frequency for the microprocessor. The Rockwell 6511 microprocessor is the brains of the board. The 2K×8 CMOS RAM contains the buffer of approximately 1700 characters. The buffer allows you to type in several lines of text to be spoken without losing any words. The EPROM is where the actual text-to-speech program resides in 8K×8 ROM.



Once you've followed these steps, Tecmar's Speech Master gives a little speech. This is your first exposure to a strange little voice with a pronounced accent. Next you can load and run Talk, which allows you to type in anything you want the computer to say.

A buffer built in to the Speech Master allows you to type in up to three lines of text at a time. If you exceed three lines, the speaking ceases. The novelty of typing in words for the Speech Master to speak wears off relatively fast, which leads to the question: "How do I put speech into the programs I'm writing?"

It is possible to enhance programs you write with speech synthesis, but it is not all that easy with the Tecmar board. Speech Master allows you to do programming with the fixed speech or text-to-speech. With fixed speech you are limited to 147 words (see Figure 2), while with text-to-speech, there is no limit.

Tecmar plans to release a model with more expansion modules of fixed speech to increase the number of custom words available. The board now comes with the first two modules filled—that's where the 147 words are—and has six expansion slots for future modules.

In using the Speech Master manual to write programs, the nontechnical PC own-



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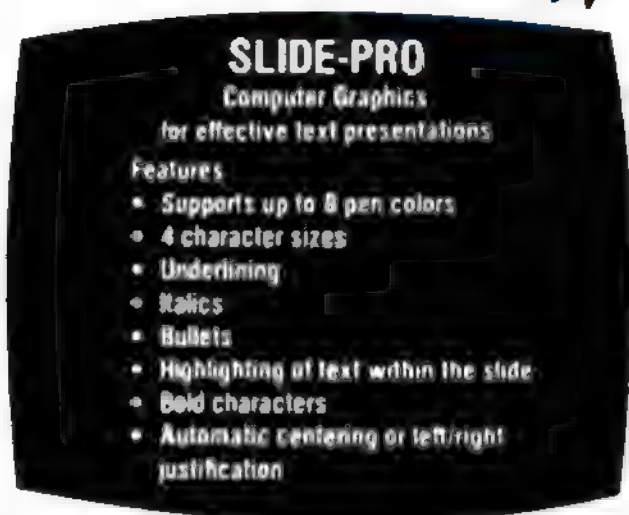
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er can easily get lost. Such a lack of clear, easy-to-understand instructions points toward a real need for a tutorial for the first-time user.

Producing speech with the Speech Master requires setting the base port address and then using either the fixed vocabulary in ROM or the text-to-speech synthesis process on the VOTRAX chip. You then send the word or phoneme code to the selected synthesizer for the actual speech synthesis to take place.

After having looked at how the demo programs were written, I wrote a simple program using the LPRINT statement to put speech into the programs I'm writing. The process wasn't quite as simple as it sounds. What it all boils down to is adding extra lines to your program to make it talk.

**YOU CAN**  
*vary the pitch and tone  
and even make your PC  
sing.*

I noticed two annoying distractions when using the Speech Master. The text-to-speech voice was quick and choppy, and its Danish accent wore thin after awhile. Compared to the Echo, the Speech Master needed many more words spelled

## Man-Machine Communication

*Remember HAL, the lip-reading computer in Stanley Kubrick's 2001: A Space Odyssey? You're not the only one.*

Dr. Hisashi Wakita, president of the Speech Technology Laboratory in Santa Barbara, California, recently discussed the future of speech synthesis with author Bil. Alvernaz. Dr. Wakita is noted for his in-depth work and research over the past 20 years in many areas of speech, including voice synthesis and voice recognition. He is currently involved in a research project on automatic speech recognition.

**Alvernaz:** What does the future hold for speech synthesis?

**Wakita:** Speech synthesis and recognition will play an important role in man-machine communication. In other words, you speak to the computer, it then talks to you, and it does what you asked it to do.

**Alvernaz:** Do you mean a computer similar to the H.A.L. 9000 in the movie 2001: A Space Odyssey?

**Wakita:** Yes, but as far as such a speech understanding system for conversational speech is concerned, it probably won't happen this century. A computer that advanced is beyond the turn of the century. In the meantime, though, there will continue to be developments and step-by-step improvements in speech synthesis and recognition leading toward that

goal.

**Alvernaz:** Is much work being done right now on speech recognition?

**Wakita:** Yes, quite actively. In fact, speech recognition devices are currently being used in industry and are available from such companies as NEC, Verbex, Votan, and Inter-State Electronics.

**Alvernaz:** With voice recognition do the machines actually understand what you say?

**Wakita:** Yes, but in a very primitive sense. Many of them just accept verbal commands. Most of the voice recognition devices must be fine tuned to your voice before use.

**Alvernaz:** Is the vocabulary limited with voice recognition?

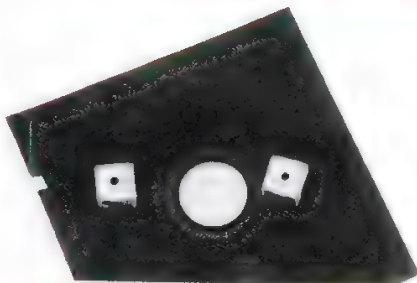
**Wakita:** Yes, very much so. Right now the recognizable vocabulary for voice recognition only includes several hundred words.

**Alvernaz:** So, as you said, we're heading toward machines which not only talk, but understand what we're saying?

**Wakita:** Yes. We are awaiting the arrival of the day when we can have computers speaking to us in measured tones of reassuring condescension like the H.A.L. 9000 in 2001.

—B.A.

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Figure 4: A list of fixed speech words for the Echo. The words are clearly spoken in a feminine voice. The variety of words to choose from means that your own programs, which you customize with synthesized speech, should be fairly complete from a talking computer standpoint.

a	able	about	above
across	act	action	add
addition	after	again	against
ago	air	aliens	all
almost	along	already	also
although	always	am	American
among	ampersand	an	and
animal	another	answer	any
anything	apple	aqua	are
area	around	arrow	as
asked	assume	at	available
away	b	back	became
because	become	been	before
began	behind	being	bell
better	between	big	billion
black	blue	board	body
book	both	bottom	boy
boys	brought	brown	business
but	by	c	call
called	calling	came	can
cannot	car	card	case
cassette	cent	center	certain
change	check	children	choice
church	circle	city	clear
clock	close	closed	code
cold	college	color	column
come	comma	command	company
complete	completed	computer	connected
console	controller	correct	could
country	course	cut	cyan
d	dark	data	day
death	development	device	did
different	disk drive	diskette	divide
division	do	does	dog
doing	dollar	done	door
dos	double	down	draw
drawing	during	e	each
early	earth	eat	Echo
economic	eighteen	eighty	either
electronics	eleven	else	end
English	enough	enter	error
escape	even	ever	every
exactly	example	experience	f
face	fact	family	far
fast	father	federal	feel
feet	felt	few	field

phonetically to sound correct. With speech synthesis, it is so much nicer to have a word spelled properly and then pronounced correctly.

### Something to Talk About

Milo Street, president and founder of Street Electronics, did his homework and also learned from his 3 years of marketing the Echo II for Apple computers. He has produced a real winner with the Echo Speech Synthesizer (General Purpose Unit).

The Echo is not only affordable, but it wraps up a very complex process in a simple little charcoal colored box smaller than a box of diskettes. All you do is plug it in and you're ready to go!

And if that news isn't good enough, the Echo is easy to use. The documentation comes in the form of a manual with 50 readable pages and a helpful tutorial. Using the Echo is simple. You buy it, take it home, and connect it to your PC through the serial port.

If there are any drawbacks to the Echo, one might be the serial connection. If you currently use your serial port for a printer, you'll have to switch cable connections every time you want the computer to talk instead of print, or vice-versa. However, you don't have to open up the PC to use Echo which is a blessing considering other demands on the PC's limited supply of expansion slots.

The Echo has an on/off switch. A red light lets you know when it is on, a useful feature that will keep you from leaving the unit turned on all night. Every time you turn on the Echo, it responds with "Echo ready." To generate speech, all you need to do is use an LPRINT statement while in BASIC or BASICA. The manual provides a simple 11-line program for typing in words to be spoken, similar to the Speech Master's Talk program.

In its Apple version, Street Electronics kept the procedures for speech synthesis simple. And, wisely, that philosophy has been continued with the Echo.

Ease of use is an understatement and just part of what makes using the Echo so sweet. The Echo has so many easy-to-use options that you might never use them all. However, it's nice to know that you can speed up or slow down the Echo's speech. You can also vary the pitch and tone and even make your PC sing. The system ranges over nearly three octaves.



The text-to-speech process can be manipulated to sound quite human. The actual voice of the Echo has a soft, friendly tone, without much of an accent at all.

At the heart of the Echo is the Texas Instruments' 5220 speech chip. Combined with a Rockwell 6511 microprocessor and a speaker/amplifier, it's an impressive compact package (see Figure 3).

***THE VOICE***  
of the Echo has a soft,  
friendly tone to it,  
without much of an  
accent at all.

The manual for the Echo starts out with a description of the product and an installation section that is very helpful. It answers the questions you'll most likely have on your mind, and informs you about everything you need to know about speech synthesis and how it relates to making your PC talk. The manual assumes that you want to know as much as possible, and it does a good job of explaining in plain English.

The Echo has a built in buffer that allows you to type up to 1700 characters for your PC to speak at one time. This translates into much more than the Speech Master's buffer of only three lines.

The tutorial is outstanding. It begins: While typing in phrases for the Echo to speak, you may have come across a word or two which the Echo has mispronounced. Although the Textalker program, which is what makes the Echo talk, uses many rules (almost 400 in fact) to guide it in correctly pronouncing your text, English is so full of exceptions to these rules that it is simply not feasible to make a perfect unlimited vocabulary. With a few simple guidelines, you can help to bridge the gap between the Echo and perfection.

#### Echo fixed speech words (con't).

fifteen	fifth	fifty	figure
find	fine	finish	finished
fire	first	fish	fit
following	food	form	forty
found	fourteen	fourth	fraction
free	from	front	future
g	game	gave	general
get	getting	give	given
go	God	going	good
good work	goodbye	got	government
gray	great	green	ground
group	grow	guess	h
had	half	hand	hard
has	have	having	he
he is	head	heard	held
hello	help	her	here
high	higher	him	himself
his	history	hit	home
hour	house	how	however
human	hundred	hurry	I
I am	I win	idea	identification
if	important	in	inch
inches	individual	information	inside
instruction	interest	into	is
it	it is	itself	j
job	John	joystick	just
k	keep	key	keyboard
kind	knew	know	known
l	land	large	larger
largest	laser	last	later
law	learn	learned	least
leave	left	less	let
letter	life	light	like
line	little	live	lived
living	load	loading	local
long	look	looked	looking
low	lower	m	made
magenta	major	make	making
man	many	matter	may
me	mean	medium	member
memory	men	message	middle
might	mile	million	mind
minute	miss	module	moment
money	monitor	more	morning
most	mother	move	Mr
Mrs	Ms	much	multiplication

The Echo works so well, it comes close to perfection. The tutorial goes on to explain

Echo fixed speech words (con't).

multiply	must	my	n
name	national	near	neat
need	negative	never	new
next	nice try	night	nineteen
ninety	no	not	nothing
now	number	numerator	o
o'clock	of	off	office
often	old	on	once
only	open	or	orange
order	other	out	over
own	p	paddle	page
paper	part	partner	past
people	per	perhaps	period
personal	photo	picture	pink
place	plant	play	please
point	political	position	positive
possible	power	present	president
press	print	printer	probably
problem	program	proud	public
purple	put	putting	q
question	quite	r	ram
random	rather	ray	ready
ready to	real	really	reason
start	recorder	red	reed
refer	remember	reset	rest
result	return	rewind	right
ringing	rom	room	round
row	run	s	said
same	save	saving	saw
say	says	school	screen
second	seconds	seemed	seems
seen	select	select one of the following	sense
sentence	service	set	seventeen
seventy	several	shall	shape
she	she is	shift	short
shorter	should	show	shown
side	since	sixteen	sixty
slot	slow	small	smaller
smallest	so	social	society
some	something	sometime	soon
sorry	sound	south	space
speak	speakeasy	speaker	special
speech	spell	sport	square
start	started	state	step
still	stop	story	street

that words like typewriter need to be spelled as two words (type and then writer). A word like robot needs to be spelled rowbot.

**S**PEECH  
synthesis has yet to  
arrive at the point  
where every PC owner  
needs the talking  
computer option.

While you do need to misspell certain words, with the Echo this requirement is minimized. The promotional brochure for the Echo states that it is 90 percent effective at pronouncing words, and I found this to be a reasonable statement.

The next section of the tutorial covers the commands that allow you to operate the Echo in different modes. The Ctrl key, combined with letters, is used to manipulate how the speech sounds or, as the manual refers to it, to activate different modes of the Echo.

By using a Ctrl EE command, you can expand how the Echo speaks, meaning that the synthesized speech will be slower. You can compress or speed up the speech by using Ctrl EC. You have the option of having the Echo pronounce each letter as you type it instead of saying each word. This is accomplished with Ctrl EL (L for letter). To go back to having the words spoken you use Ctrl EW. Using the commands is quite simple. The Ctrl E is always followed by the first letter of the word describing what you want. C for compressed, E for expanded, and so forth.

The Echo will even pronounce all punctuation characters except spaces, line feeds, and carriage returns. Pitch can be adjusted to an incredible 63 different levels. If you should want robotlike speech, you can do that by putting in a flat pitch.

The tutorial doesn't end there. It goes on to actually show you more about how to use all of your newfound knowledge. The end of the section gives you more useful technical information and understand-



able explanations of the types of sounds represented by the phoneme codes.

The six categories of phoneme codes are explained exceptionally well:

**VOICED CONSONANTS AND UN-VOICED FRICATIVES:** Each of the voiced consonants is created by vibrating your vocal cords. Place your fingertips against your adam's apple and say the voiced consonant "zzzzzzzzzzz." The sensation you feel with your fingertips is the vibration of the vocal cords. Contrast this with the lack of sensation which should result when you say the unvoiced fricative "sssssssss." The "s" sound is not produced by vibrating the vocal cords, but through friction, produced as air flows over the various parts of the vocal tract.

The manual includes a sample phoneme vocabulary, plus the codes and commands necessary to manipulate the Echo. This section of the manual is extremely helpful as a quick reference. For the real beginners, there is even a section of the manual explaining how to get your PC up and running in BASIC or BASICA to use the Echo. There just isn't anything left out in the manual—all in only 50 pages. For those who do programming and want a more sophisticated voice from the Echo, Street Electronics offers fixed speech in a software package for an additional \$29.95. The voice is feminine and pleasing to the ear. The best news of all is that this diskette contains close to 700 words (see Figure 4), a more realistic number to work with than Speech Master's 147. To include fixed-speech words in your own programs, you need as many words as possible for flexibility. And that flexibility is built in with Echo's additional 500 words.

A special editor program or series of instructional prompts walks you through using the fixed speech disk. This works much more simply than Speech Master's fixed voice option does. With the Echo all you do is "pull" the words you want off the disk and store them in the program you're writing. The words will then be there, to be spoken, whenever you command them to do so with the LPRINT statement.

The driver program, which puts the selected words on your program disk, uses

#### Echo fixed speech words (con't).

study	subtract	subtraction	such
sum	sun	supposed	sure
switch	synthesizer	system	t
table	take	taken	teen
telephone	television	tell	ten
textalker	than	thank you	that
that is correct	that is right	the	their
them	themselves	then	there
these	they	they are	thing
think	third	thirteen	thirty
this	those	though	thought
thousand	threw	through	thus
time	today	together	told
tone	took	top	torpedo
toward	tree	triangle	true
try	try again	turn	turned
twelve	twenty	type	u
under	understand	United States	until
up	upon	upper	us
use	used	using	usually
v	very	w	wait
want	wanted	war	was
water	way	we	we are
week	welcome	well	went
were	west	what	what was that
when	where	whether	which
while	white	who	whole
whose	why	will	wind
with	within	without	word
work	working	world	would
x	y	year	yellow
yes	yet	you are	you win
young	your	z	zero



approximately 1K. Each word uses up roughly 150 bytes. The memory drain will add up quickly depending on how many words you put in your program, but what's nice is that you can customize your programs, using fixed speech or text-to-speech.

With fixed speech you have most of the

same options as with text-to-speech. You can lower or raise the voice, and make it talk fast or slow. You can change the inflection and pitch to match the inflection of questions or statements of exclamation.

The Echo and the fixed-speech disk can be combined to make a complete, rea-

sonable package for anyone interested in making the PC talk. Having been around for 3 years now with Apple computers, Echo has numerous productive uses, rang-

**SPEECH**  
*added a sense of life,  
individuality, and  
uniqueness to our PC.*

ing from Rosegrant's program to a word processing program for blind people. Business and industry are using the Echo also. It's hard not to be impressed by how well it works, how simple it is to use, and at how reasonably it is priced.

#### Talking a Little Better

A talking PC takes a little bit of getting used to. There are two reasons for this. One is that the actual computer-generated voice, especially with text-to-speech, sounds strange. The other and more significant reason is that people do not speak as well as we should; we don't enunciate clearly.

Take, for example, the question, "How are you doing?" What we really say is, "How ya doin'?" When you type in "How are you doing?" that's exactly what the Echo or the Speech Master will say, and correctly, too. So, yes, it does sound different, but only because we chop off words as we speak. Think about it. Even "good night" is butchered to "ga-nite."

Speech synthesis has yet to arrive at the point where every PC owner needs the talking computer option. But there is a certain magic in listening to a computer named Joshua talk in War Games. After seeing the movie, my family felt some of that magic.

We noticed a personality change in our PC once it started talking. We knew it was only able to speak through a special technological process, in response to what we typed in on the keyboard, but somehow it seemed to be more than just a machine talking. Speech added a sense of life, individuality, and uniqueness to our PC. And for those of us who do quite a bit of programming, speech synthesis will continue to grow in importance, too. /PC

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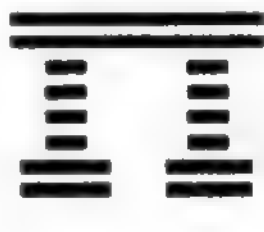
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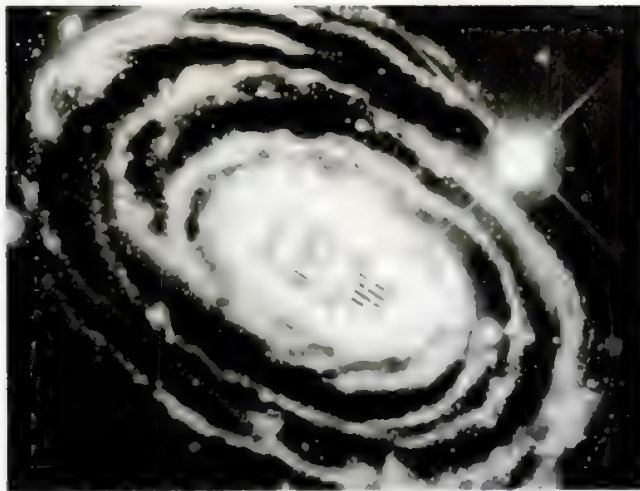
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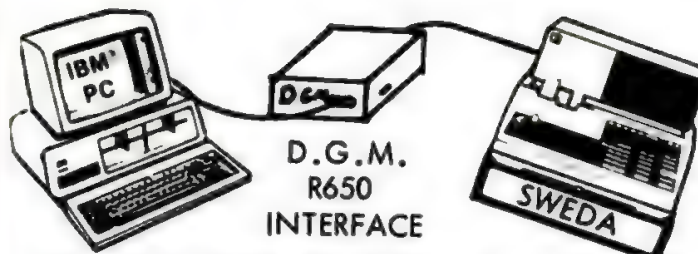
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*General Electric Information Services, a GE subsidiary, sells and services IBM PCs to encourage hookup to its mainframe databases.*

# GE's \$10 Million

## PC Connection

Ten million dollars buys a lot of PCs and XT's. And while General Electric Information Services (GEIS) Company executives are keeping their lips sealed about the exact number of IBM micros their \$10 million is buying, several things are certain.

For one, the GE/IBM agreement will speed the integration of microcomputers into the world's largest commercially available teleprocessing network. Further, new software developed to make such integration possible will prove useful to individual PC users who would like

access to megacomputer capabilities. Third, the likelihood that many more businesses will be using IBM micros in their day-to-day operations is likely to stimulate development of more stand-alone software for the PC.

### GEIS and the Micros

But let's take things step by step. First, what is GE Information Services, and why is it purchasing all those microcomputers from IBM?

The thriving company, based in the booming Washington, D.C. suburb of Rockville, Maryland, is a wholly-owned subsidiary of General Electric. In 1982, GE Information Services revenue topped \$600 million. Through three "Supercenters"—in Rockville, Ohio, and Amsterdam—with 450 processing and communications computers, the company provides a teleprocessing network, central processing, databases, and a library of more than 2,000 software programs to more than 6,000 business clients around the world.

The Rockville Supercenter, a monument to high technology, is set incongruously near working farms and car dealerships just a short drive away from GE's microcomputer products unit. The high-security facility has its own back-up generator to guard against power interruptions. It boasts a host of Honeywell and IBM mainframes, tape drives, communications controllers, and processors, complete with thermo-humidigraphs to maintain constant temperature and humidity levels.

The GE/IBM macro-sized micro-deal is aimed at making massive central comput-

ing capacity available to users of personal computers. "We want to make it easy for customers to do local processing and tie in with the mainframe," explained Michael Olfe of the GE Information Services Microcomputer Ventures unit. For a company like GE, which already maintains such a teleprocessing capability, the potential of micros is staggering. As Dr. Ruann E. Pengov, manager of marketing services

---

**GE DECIDED**  
*that the surest way to  
capitalize on the  
microcomputer potential  
was to purchase micros  
and market them to its  
own customers.*

---

operation, predicted at the INTERFACE '83 Conference earlier this year, "In 1986, microcomputers will be in operation on over 19 million desks worldwide, compared to over 6 million in 1983."

"The full benefit of microcomputers will not be realized until they are successfully integrated into an organization's data-processing solutions," Pengov told her audience. A key part of her company's mission is to persuade data-processing managers that ignoring the potential of

micros can be a costly mistake measured in a waste of processing power, time, and productivity.

GEIS promotes integration of microcomputers by helping build what management-information systems (MIS) executives call data integrity. The GEIS system makes it relatively simple to upload data automatically from the micros to update the mainframe.

According to Olfe, all common program formats can be uploaded and manipulated on the host. For example, a certified public accounting firm could download information on the latest changes in tax rules from the GEIS mainframe to local databases, providing an added quality factor. Or when a project involves interrelated modules, the system can automatically record the status of updated modules so that co-workers using other microcomputers will know when something has changed, even if they had been unaware that someone was working on it.

### Making Predictions Come True

GE decided that the surest way to capitalize on the microcomputer potential was to purchase micros and market them to its own customers. The choice of which micro to buy wasn't obvious at first, recalled Steven P. Korn, the company's microcomputer products manager. Why then IBM? "It was a marketing decision based on IBM's credibility and presence in the marketplace," Korn said.

GE Information Services is purchasing complete IBM systems, including IBM drives and IBM monitors. Because of legal and logistical problems, GE has been



The IBM 3081 furnishes the raw computing power for the General Electric Information Services (GEIS) MARK 3000™ Service at the Rockville, Maryland Supercenter.



Operator at major console area monitoring service.

Photographs: Robert R. Randolph/GEIS



reselling the hardware only in the United States and Canada so far, although some customers in Europe have obtained their own PCs, Korn said. One company goal, as he described it, is "to find a way to deliver and maintain the equipment anywhere in the world." This capability would enable multinational clients to standardize their configurations around the globe, he said.

GE assembles, stages, tests, and installs the micros itself according to configurations specified by the customers. GE also accepts responsibility for total application support, including hardware maintenance. Further, the company is developing and marketing appropriate software. As Olfe put it, "We want to make it unnecessary for the ultimate end-user to shop down the street for missing pieces." To reinforce this concept, GE has begun marketing the Hayes Smartmodem, preferably bundled with the IBM hardware and GE-offered software.

Although the company markets only IBM micros, it has qualified the Apple II Plus and the Tandy TRS-80 Model II for use with the GE network. Clients have to acquire those brands on their own. In the future, the company will consider other machines (some more powerful than the Apple and Tandy models as well as some portables) for use with the system, Korn said. Evaluations of a number of portable units are being conducted this year to determine which portables will qualify for use with the GE teleprocessing network. Rating criteria will include ruggedness and reliability, how much of the IBM PC's functionality is preserved by the portable, and whether it will appeal to the end-

users. Korn added that GE may simply qualify some portables (such as it now does with the Apples and TRS-80s), or it may arrange a mass purchase and resale deal similar to its arrangement with IBM "if there's enough (financial) margin in the hardware."

### **Demonstrating the Micro/Mainframe Link**

For the end users, the marriage of micros to host allows communication between multiple sites within an organization. There's an old saying, "Do as I say, not as I do." GE is practicing what it preaches.

GE staff recently demonstrated a program called Pipeline, which is used by the company's sales representatives in the field. On a daily basis, field reps enter information about prospective customers into remote PCs. The field reps and their superiors use the data to assess the chances of completing a business arrangement and then to project revenues if a contract is signed with a new customer.

A similar concept underlies a system used by GE's Contractor Equipment Business Operations to link more than 50 sales offices across the country with GE's manufacturing plants. The system allows users to enter and validate data, and generate local reports without accessing a Supercenter. It is also used to transmit sales propositions to a plant or headquarters through the mainframes. Although "express" or immediate transmission is required at times, the company favors the less-costly alternative of deferred transmission during off-peak hours. A program

has been developed to transmit automatically at a predetermined hour when the

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**W**E'RE SELLING  
*distributive data  
processing. We're not  
selling machines.*

---

PC uses a Racal-Vadic auto-dial modem to initiate communications with the host.

### **Distributive Data Processing**

The GE-abetted proliferation of personal computers is intended to encourage existing clients to use the mainframe more often and to induce potential customers to sign on for time-sharing and software. "We're selling distributive data processing. We're not selling machines," Olfe emphasized.

GE Information Services says it's discovering a growing new customer base. "Those who haven't used time-sharing before value the fact that they can tie into the mainframe," Olfe continued. The marketing effort pushes the versatility of the PCs both for stand-alone functions and for communicating with the host. Korn added, "We do local data processing when it makes sense, and we do remote when it makes sense."

That philosophy is apparently paying off. Again, GE Information Services won't release figures on how much of its \$10



*The heart of the network. The electronic data switching equipment scans the current workload and seeks out the most efficient routing of data. During a peak load hour, the network can handle more than 6000 users simultaneously.*



*Operator monitoring GEIS direct and dedicated customer lines at Rockville.*

million order has been spoken for by clients or how many microcomputers any particular customer has ordered. What Korn will say is this: "We have more orders than we can at times deliver." No specific numbers are being made public, but Korn did disclose that some clients are buying several hundred units.

Under one of the largest agreements negotiated so far, a statewide nonprofit health insurance group is ordering several

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## ***T***HE NEW GE venture has ramifications far beyond the mass purchase and distribution of thousands of micros.

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hundred XTs from GE Information Services for an innovative physician claims system. Under the plan, participating physicians will buy XTs from GE Information Services to maintain local databases on health insurance claims. Each day, the physicians' staffs will enter all the information normally filled in by hand on the claims forms now in use. Each night (when telecommunications rates are low) that data will be transferred to the mainframe so that the insurance group can consolidate the claims.

"It will mean lower claims-processing costs and a faster turnaround time on payment of claims," Korn said. "Also, the mainframe will automatically notify physicians via their XTs when any information needed to process a claim is missing. The doctor ultimately will be able to query the current status of a claim. Where is it? When will I be paid?" Korn continued.

The physician claims system is scheduled to begin operation sometime during the last 3 months of 1983. If successful, it will be made available in other states, opening a vast new potential market for GE Information Services and IBM. "That's the part that excites us most," Korn said, noting that GE has already received many inquiries from other insurers eagerly eyeing the project. The doctors can also use their XTs for office automation and local

data processing, Korn added.

### **Software Linkage and Development**

The new GE venture has ramifications far beyond the mass purchase and distribution of thousands of micros. The company is pursuing a three-prong strategy, and each prong has major implications for software developers and for authors in search of markets.

The first thrust is communications. Late last year, GE began marketing the first version of its software linkage program, Time Sharing Interface (TSI 1.0). Although developed to serve customers who want to integrate their micros with the GE mainframes, TSI 1.0 has proven a hit elsewhere. "People are seeking us out and purchasing our communications software," Korn observed, adding with a smile, "Our competitors are buying it too." The company has not yet formulated a policy on how aggressively it wants to market to nonclients. While outside marketing would be a source of revenue, the availability of software tailored to integrated systems is regarded as a major selling point for potential Supercenter users. Korn said, "It's part of our competitive advantage."

A more sophisticated version of the TSI 1.0 was released this summer. Billed as a major revision, TSI 2.0 incorporates a dialing directory, automatic log-on, a horizontal split-screen function, the capability of creating session files, and the ability to construct incoming and outgoing masks and to remap the keyboard, among other features.

Making "productivity tools" available to clients is the second thrust of GE's strategy. The third strategic thrust is to attack vertical markets—transportation, international finance, and insurance among them—with a complete range of software suitable for both local and remote data processing projects. It is these two elements of the company's approach that should interest software authors.

Although GE Information Services already offers more than 2,000 programs for clients of its teleprocessing network, these are by no means enough, company officials stress. Even for those programs already in GE's software library, "development is required in every case" before they will be suitable for the PCs and XTs, Olfe pointed out. Equally important, GE is

doing little of the necessary software development in-house.

Much of the emphasis is on modifying existing programs and applications, whether originally designed for mainframes or for microcomputers. Korn observed, "People don't expect to pay as much as in the past to develop software. Despite the deep pockets of a lot of major corporations, they're not willing to underwrite development from scratch." Another reason why development from scratch is becoming rarer: time. Korn cited the examples of the finance and banking industries, whose applications needs change with the regulations every 6 months."

"My phone rings a couple of times a week" with authors calling GE Information Services offering proposals, Korn said. He added, "It should be ringing a hundred times a week." So where does the company find authors? Almost anywhere, including trade shows and PC conferences. "We want the winners, the best ones that take advantage of our network and our services," Korn stressed.

GEIS is also hunting among the authors who've already done programming for the network's mainframes. GE is asking its present stable of authors to modify their programs for use in the integrated system and inviting them to write new programs. That corps of authors is significant in itself; the most recent edition of the company's directory of author programs runs to 168 pages. GE offers tools, assistance,

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## ***D***ESPITE THE deep pockets of a lot of major corporations, they're not willing to underwrite development from scratch.

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and guidance to help those authors keep current.

As an example of a mainframe software developer creating another version suitable for use on the personal computers, consider Evaluation and Planning Systems Consultants Inc. of Windham, New



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Hampshire. GE Information Services is already making available both mainframe and micro versions of the firm's decision support system, which is designed to serve the needs of corporate financial managers and analysts. Evaluation and Planning Systems Consultants licensed the program to GE, which is marketing the system both in the United States and abroad. Among its applications are investment analysis, budget control and development, long-range planning, merger and acquisition activity, cash-flow forecasting, statistical studies, and what-if scenarios. It includes a data manager, a report generator, and an editor. And it possesses graphics, hierarchy and consolidation, and data management capabilities. Korn said that customers can buy rights to either version, though GE maintains that purchasing both provides "the best of both worlds."

Another example of software available for use on both the PC and host is a worldwide procurement-tracking system developed for Bechtel Company, the interna-

tional engineering and construction concern based in San Francisco. The system centralizes shipping and logistics control and simultaneously links a multi-billion dollar airport construction site in the Saudi Arabian desert with ports in North America, Asia, and Europe.

GEIS is actively searching for new microcomputer authors, some of whom may already have designed stand-alone software and would benefit financially and professionally from a tie-in with GE. With access to GE's time-sharing network and its databases, those authors may be able to do things they couldn't do alone, Korn said. To illustrate his point, he added that an author may need to use GE's Fortran subroutine library. They may need help in bringing their software up to the system's standards, debugging and using the special features of the PC, including handling the communications port and string features. The authors also stand to gain from GE's sales force. "Let's face it," Korn said, "the big bucks are in marketing."

## Dealing with Software Authors

GE's staff helps would-be authors evaluate their proposals and negotiates compensation and marketing arrangements. The company offers a menu of financial arrangements for its authors in addition to the professional advantage of providing access to technology that otherwise may not be available to them.

For example, GE Information Services may offer an author a financial package with an upfront, one-time royalty. Or royalties may be based on the number and price of copies sold. The way a product is marketed also affects payments. In many cases, GE's worldwide sales force may assume full responsibility for marketing the program. At other times, authors may prefer to handle marketing themselves, especially if their software has been developed for a specialized industry.

Company officials acknowledge the need to treat micro authors differently from developers of mainframe software. Once again, time is a factor. Sometimes, the shelf-time for a software program is short—perhaps 9 months to a year. "We can't spend 9 months in negotiation," Korn said. And naturally, an author's perception of a program won't always coincide with the company's: "Sometimes the author's confidence in the package is greater than ours," Korn added.

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**WE WANT TO**  
*stay in certain markets,  
even if a particular  
product isn't going to  
make us rich.*

chance of signing on with GE?

This is where the third prong of the strategy—vertical markets—comes in. Many of what the company labels "targets of market opportunity" are vertical industries such as energy, transportation, banking, and public accounting. In addition to vertical industries, GE also is targeting some horizontal markets including manufacturing, finance, and order service.



In transportation, for example, an author may develop software that allows large firms to keep track of the status of

## **T**O HELP customers make the most of integrated microcomputers, GE Information Services has started offering training on the IBM PC.

their trucking fleets, enabling regional offices to determine where each truck is, its condition and its availability for a shipment to a particular location that requires a specified number of days in transit. The program, using the capabilities of both the XT and the mainframe, would replace a prior setup in which communications were handled by phone.

Even if your software package isn't worth much to GE by itself—perhaps because of a limited probable market—GE could still be interested if it falls into one of the target areas. The aim is to maintain as wide a presence as possible in those fields where GE is strong and where the overall opportunities for profit are great. As Olfe explained, "We want to stay in certain markets, even if a particular product isn't going to make us rich."

With thousands of potential authors out there, it would seem that competition can get heavy, and it's going on in what company officials describe as "the battle of the marketplace." GE is resistant to the concept of exclusivity in seeking new programs to handle particular applications. Here's how Korn explained the GE philosophy on the issue: "There is conflict. They compete with our own products. You do have overlap. You do have duplications. We have authors competing with authors, we have authors competing with our products, but the principle competition is the author against the outside world." Korn added, "the marketplace will vote with their dollars on which software package is the winner."

### **Training**

To help customers make the most of integrated microcomputers, GE Information Services has started offering training on the IBM PC.

The first course, called "Introduction to IBM Personal Computer," provides menu-oriented instruction on the fundamentals of PC use and covers use of TSI as well. It is available on a self-paced disk. The modular approach takes about 8 hours to complete. Alternatively, it is offered in a more formal 2-day classroom version at the customer's own site. The company says the advantage of the classroom approach is its greater emphasis on performing practice exercises and the opportunity to ask questions of a live instructor.


Another micro-related course will deal with BASIC, also targeted for individuals with little or no prior computer experience. GE said that those who complete its BASIC course will be able to write simple programs, do calculations, read from and write to files, and use the BASIC editor. A

third course is planned on other applications for the PC. These, too, will be available on diskette or in the classroom, according to the company.

The training and the proliferation of PCs flowing from the IBM/GE arrangement can't be viewed in a vacuum. The implications reach beyond any particular business, whether IBM, GE, or a teleprocessing customer.

In mega-terms, the \$10 million agreement means a great increase in the number of personal computers for businesses. On a micro-level it will result in the introduction of individuals to the versatility of the PC. It will put convenient access to computing resources in the hands of more clerical, professional, and managerial workers whose prior computer exposure may have been limited to asking specialists to do particular tasks or to playing video games at home. Although that type of exposure may not have been the principal motive behind the IBM/GE transaction, in the long run it could prove to be one of the contract's most important legacies. /PC

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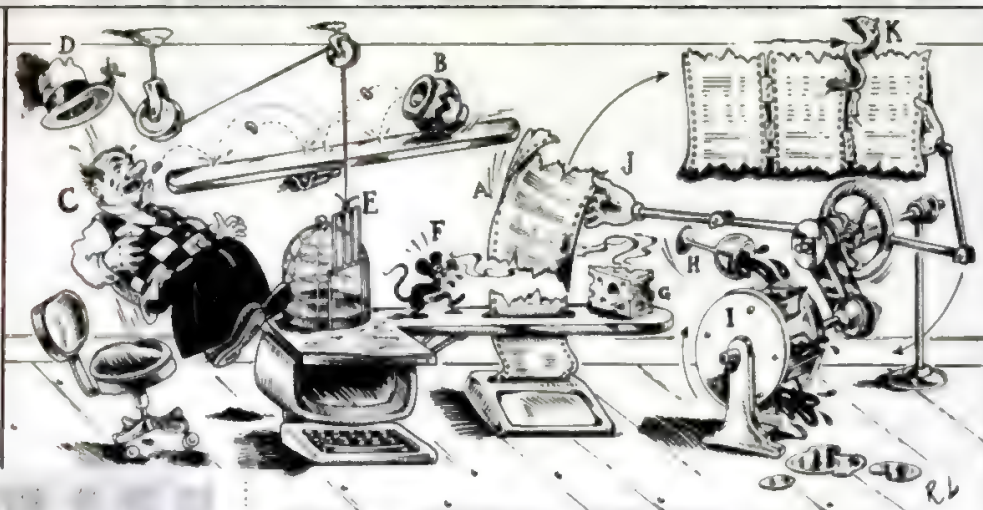
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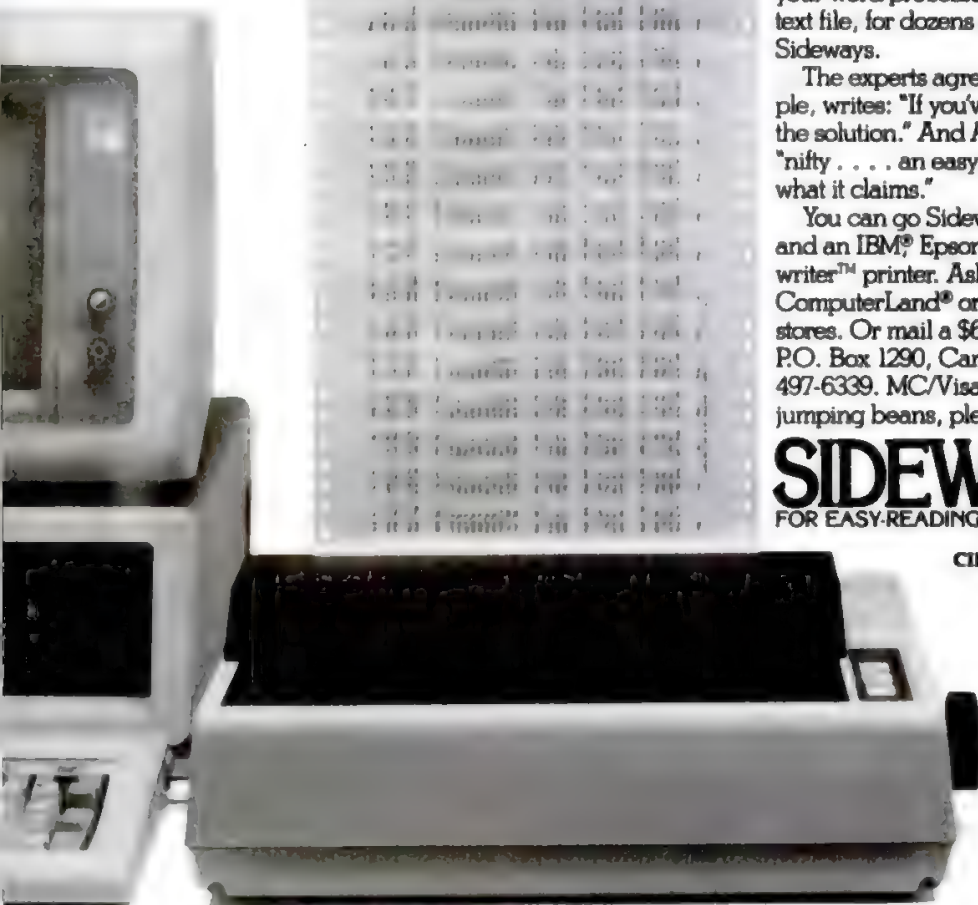
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*By using the PC to study and upgrade local emergency medical services, Ohio volunteers provide a model for the rest of the country.*

# A PC On The Emergency Squad

"Hudson EMS, respond to Terex and Hudson Drive, accident with injury." The dispatcher's voice coming in over the transceiver in my car was businesslike. Even in the tiny little town of Hudson, accidents are not infrequent, but fortunately, most injuries are minor. Except at Terex and Hudson.

"Bad intersection," I thought.

In the 3 years I'd been working with the Hudson Emergency Medical Service (EMS) as its medical advisor, I'd reviewed more than just a few reports of major collisions there.

I looked over at my wife. We were on our way to do some shopping and weren't even really heading up that way. She sighed.

"Go ahead. It's all right."

I turned the car and headed up toward the accident, listening for anything else on the radio that might tell me what to expect. "Med 11's en route." I could hear its siren wailing in the distance, and decided there was no reason for us to drive any faster. The ambulance would probably pass us soon and we'd both be there in a couple of minutes.

The radio crackled again: "201, Med 11. Step on it!"

I recognized the police officer's voice; the sense of urgency was unmistakable. These guys didn't call for help unless they needed it. I hit the switches for the emergency lights and suddenly beams of flashing red and white light cut through the night from the front and top of the car. The next switch released the siren's wail from under the hood.

I spoke into the microphone, trying to sound calm: "Med 10, Med 11. I'm responding hot to that call. I'm in front of you, ETA 30 seconds."

The flashing blue lights from the police cars appeared ahead and seconds later I pulled up and saw just what I had feared; glass was scattered all over the intersection and the twisted wreckage made it all too clear that either or both vehicles had been going at a pretty good clip. The scene took on an eerie cast, as the white, red, and blue lights strobed the center of the intersection. The headlights and emergency flashers of passing cars illuminated the faces of their occupants, adding to the sense of unreality. Radio static and the shouts of the squad crew and police mixed with the moans and sobs of the victims.

Within seconds the crew chief had made her initial assessment and had set in

motion the efficient machinery, which would see the two injured people out of their cars and on their way to the hospital in the safest, quickest way possible. Tasks were assigned, equipment was mobilized, and the emergency medical technicians (EMTs) took their positions inside and outside the wrecked cars to begin the extrication process.

By now, you're probably wondering what all this has to do with the PC. Several years ago I would have wondered too. But today, only 6 short months after I installed a PC at home and brought its capabilities to bear on my work with rescue squads, I'm wondering how I ever got along without it. Quite simply, the Hudson EMS, and the other rescue squads I work with all over the county, are moving to the forefront of emergency medicine in this country, and the PC is helping in that task.

## An Unlikely Spot

The sleepy little town of Hudson, Ohio seems an unlikely spot for such lofty aspirations. After all, rescue squads and emergency medical services are usually thought of in the context of a big city, as in TV's "Emergency" or "240-Robert." And, there's no doubt about it: L.A. we ain't.

Located in the Western Reserve (the land formerly owned by the state of Connecticut as a "western reserve"), Hudson's New England roots show through in the spirit of independence and self-reliance of the townspeople as well as in its local architecture. The people are friendly and proud, and a sense of tradition is officially guarded by the local historical society. The ice cream social still draws the largest turnout of any annual social occasion and it's held on the Village Green, flanked by

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**I****F YOU**  
*had an accident out on  
the highway, your fate  
depended on where you  
happened to be or  
whether the local  
funeral home ran an  
ambulance service.*

---

Main Street's row of little shops on one side and Town Hall on East Main on the other.

Crime in the streets is duly recorded in the local weekly paper where the week's most serious offenses noted in the "Police Blotter" may include a bicycle stolen from in front of the drugstore. (Yes, it has a soda fountain, and yes, you can get a chocolate phosphate.) The local constabulary is periodically dispatched to deal with a horse or cow that has broken through a fence and is wandering in the street.

How is it, then, that such exciting events in the world of EMS are emerging from this little hamlet and the others like it around the county?

Hudson provides some of its municipal services through volunteer participation. Both its fire department and emergency medical service are staffed by people who do what they do because they want to help, just like the people in many small towns across the country. But when I arrived in Hudson 3 years ago, the Hudson EMS had just embarked on the ambitious project of upgrading the service to what is commonly called "Advanced Life Support" (ALS), which requires the close

cooperation and approval of a physician or medical advisor. Claire Truesdale, Hudson's full-time administrator/paramedic, told me simply, "We want to be the best. What do we have to do?"

The answer to this question is precisely what makes this region's EMS so unusual. But I'm getting a little ahead of myself. What's happening within EMS in Hudson is part of a much larger transformation: Something close to a revolution is occurring in this country.

### **You Call. We Haul!**

Twenty years ago there was nothing really resembling EMS as we know it today. If you had an accident out on the highway, your fate depended on where you happened to be, who passed by, or whether the local funeral home ran an ambulance service. If it did, and someone did call it, what happened to you when the ambulance arrived at the scene was anybody's guess. If you were lucky, one of the attendants might have had a first aid course. In any case, they pretty much just scooped the victim up and tore off to the nearest hospital in a tradition that has come to be widely known (and scorned) as "Scoop & run" or "You call, we haul." But "Scoop & run" really had something going for it when you consider that the alternative was called "Lie & die."

In 1966, the National Academy of Sciences (NAS) published a landmark monograph entitled, *Accidental Death & Disability: The Neglected Disease of Modern Society*, which changed the face of EMS forever. In the monograph, the NAS reviewed data on traffic injuries and came to a gruesome conclusion: People involved in accidents all over the country were being maimed or killed in awesome numbers, but not necessarily because their injuries were crippling or fatal, nor because medical science was incapable of dealing with these injuries, but because no system was available that could guarantee that victims would be transported quickly and reliably to a hospital. They were dying because, once injured, they would lie sometimes for hours, slipping into shock and then death.

Congress reacted swiftly. In the same year, the National Highway Traffic Safety Act was passed, defining for the first time standards for emergency medical services, and conferring upon the Department of Transportation primary responsibility for

the creation of training and certification standards for emergency medical technicians. The responsibilities of an EMS were put down in black and white, and a national commitment to remedy the sorry state of affairs depicted in the NAS monograph became the law of the land.

In the years that followed, training programs started all over the country, and the folks who rode the ambulances and answered calls for help began to do so with new competence and understanding. EMS groups took on a new air of professionalism; they became contemptuous of such terms as "ambulance attendant." (Free Tip: Do not refer to an EMT as an "ambulance attendant.")

### **Advanced Life Support**

But as the medical service revolution led to new capabilities, new vistas, new hopes, and new frustrations appeared. The standards for EMS had addressed the problem of trauma on the highways, but another problem, yet unsolved and equally deadly, began to occupy the attention of those who explored other concerns of pre-hospital care: heart disease.

The first few hours of a heart attack are the most critical. It is within the first few hours that heart attack deaths most frequently occur. The heart, starving for oxygen because of coronary artery blockage,

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**T****HEY WERE**  
*dying because, once  
injured, they would lie  
sometimes for hours,  
slipping into shock and  
then death.*

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becomes irritable, begins to beat irregularly, and soon may begin just wriggling uselessly instead of pumping blood. In trauma, medical professionals often talk of "the golden hour," the period of time during which the rendering of treatment will mean the difference between life or death. In cardiac arrest, the struggle between life and death may be limited to "golden minutes."



Four to six minutes after the heart stops pumping, irreversible brain damage begins. Even if bystanders begin CPR, they can at best provide only 30 to 50 percent of normal circulation and ventilation. Each minute that goes by without restoration of a heartbeat lessens the chance that subsequent attempts to restart the heart will be effective. What's needed desperately are drugs (epinephrine, sodium bicarbonate, and others), which can prime the heart's electrical system, followed by defibrillation, the application of a strong electrical current across the chest to reorganize the heart's electrical activity into meaningful heartbeats. In fact, if these measures are not applied within 12 to 15 minutes, the chance of survival diminishes to near zero.

The need for these sophisticated resuscitative techniques created a problem; these methods—the administration of powerful drugs, intravenous infusions, defibrillation—were simply not available in the field. As medical techniques, they could only be practiced by physicians, which meant that they were available only in hospitals. But even the best emergency services could not hope to get cardiac arrest victims to the hospital in time.

The solution was the paramedic, an

EMT trained beyond the basic level of rescue skills. Paramedics are capable of making a physical examination and assessing acute problems. They are trained in critical care procedures, drug administration, and cardiac resuscitation. And, under the direction of a physician, paramedics can monitor heart rhythms, start intravenous lines, administer drugs, and then transport the patient in the most stable condition offered by these treatments. The physician under whose direction the paramedic is functioning need not be present, but can provide medical direction or "medical control," as the term is often used, by two-way radio, or through predetermined written protocols and standing orders.

The availability of paramedic skills constitutes such a radically improved level of care that squads providing paramedic-level service are referred to as Advanced Life Support units. Squads without paramedic-level service are referred to as Basic Life Support (BLS) units.

In 1973, the Federal EMS Act defined the guidelines for EMS systems at all levels, and provided for the federal funding of EMS demonstration projects to be used as models for EMS planning. While the National Highway Transportation and

Safety Act assured that rescue service would become available for all who were in need, the EMS act of 1973 signified a solid commitment to move EMS definitively out of the "Scoop & run" era and into the age of professional prehospital

**L**ITTLE surprise then, that there was an IBM PC in my future.

practice. The result of that endeavor is dramatically illustrated by the statistics reflecting the growth of ALS in the United States. In 1972, only 2 percent of the population was served by EMS units with ALS capability. By 1982, new EMS units had been created and many of those already in existence had been upgraded from BLS, thereby providing over half the country's population with access to ALS service. For cities with populations greater than 150,000, that figure was 92 percent.

### Skills Maintenance

It should not, then, be too surprising to hear that in 1979, the proud little volunteer Hudson Emergency Medical Service decided to go ALS. In the 4 years since that happened, my involvement with EMS has grown along with Hudson's advancing capabilities. As associate director for EMS at Akron City Hospital, I oversee the EMS training of resident physicians in emergency medicine, coordinate prehospital field activities with the hospital for 15 different EMS units, and personally direct the medical activities of eight different squads. When I took on the position 3 years ago, it was supposed to be a part-time job. (I spend the other half of my time on duty in the emergency room seeing patients.) It has, however, rapidly and unavoidably become a full-time occupation.

Little surprise then, that there was an IBM PC in my future. With endless tasks, many of which involve the management of large quantities of data, with over 100-hour weeks and 18-hour days, anything that promised to lighten the load was welcome.



The victim has been extricated and is now on the ambulance cot on a long board. The short board immobilization device is still in place. Standing over the victim is Hudson EMS administrator and volunteer paramedic Jim Bell. The victim was moved into the med unit and transported to Akron City Hospital, where subsequent evaluation revealed only minor injuries.



I was not really a complete stranger to computers, and small computers are not completely new in EMS. When I was an undergraduate at Yale in the 60s, I had learned to program in FORTRAN on the huge and clumsy mainframe at the computer center. Those were the days when programmers punched out lines of bug-infested code on noisy keypunch machines and turned over stacks of doomed data cards to attendants who would feed them to the cardreader and return smirking with a little printout from another crashed run. (The amount of computer time doled out to beginning programmers like myself was pretty skimpy, so in addition to learning FORTRAN, I became adept at "creating" additional computer time from illicit sources.) I even had an opportunity to use one of the first IBM 360 terminal systems when it was installed at Yale. I was thrilled by how much easier it was to interact with the CRT than to go through the punch card routine at the computer center. Besides, even though the terminal didn't always do what I wanted,

at least it never smirked.

My computer days at Yale were numbered, however. I liked programming, but medical school loomed, and with many other things to occupy my time, FORTRAN and debugging receded into the past as medical school and then medical practice took center stage.

But 2 years ago computers re-emerged

## ***D** OES THE EMS need any help that I could provide with my computer?*

in my life. Stu Averill walked into the Hudson Safety Center and offered his services to the Hudson EMS. He is a retired chemist who had begun to occupy some of

his retirement time with a recently purchased TRS-80. He knew that the Hudson EMS was all volunteer, and even though he wasn't trained in rescue work, he wanted to help. "I have a computer," he told EMS administrator Claire Truesdale. "Does the EMS need any help that I could provide with my computer?"

When Truesdale passed the offer to me, I was thrilled. We immediately set Averill to work keeping track of various aspects of the service, one of the most important of which was the skill file we kept for each paramedic. With a population of only about 12,000 people to serve in Hudson, we faced a very real problem: skills maintenance.

It's estimated that a municipality must have a population of about 20,000 people before it will generate enough rescue calls to keep its paramedics proficient in various intensive care techniques. For example, a paramedic running with an urban squad may start three or four intravenous lines a day, whereas on a rural service, a paramedic might not have an opportunity

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to start one for several weeks at a time. Regardless of how well-trained the paramedic is to begin with, this kind of inactivity inevitably results in decreased proficiency. How can this be combatted in a town of 12,000?

We drew up a list of intensive care skills practiced by the paramedics and determined the minimum monthly number of times each skill needed to be performed. Any time a paramedic dropped below the minimum number, additional training and/or practice was instituted to ensure that the skill level was maintained. Just as a pilot must fly so many hours each month in order to keep his license current (and legal), our paramedics had to start so many IVs, read so many EKGs, and so on, in order to maintain standards of service. To keep track of this, Averill set up a computerized file, which tallied all the different paramedic skills performed by each paramedic. If a paramedic started an intravenous line on a run, that fact would be extracted from the run report, and at the end of the month would be reflected in a summary that gave totals for each required skill for each paramedic.

Averill also began tracking some data on the runs themselves and was soon able to provide us with periodic reports that told us how old our patients were, at what times they called us most frequently, what kind of problems they had, and so forth. Averill is still our computer person, but quite a bit has changed.

For starters, he isn't using a TRS any more; he has found the IBM PC more suited to his needs. But he's parlayed his computer work into a new business as one of the principals in the Hudson Computer Club. A first in this area, HCC is like a racquetball club; only instead of renting a court, the club members rent IBM or Apple computers by the hour. A wide array of software is available, and, of course, there is a club "pro" on hand to provide instruction and assistance. And resting like an archive in a corner of the club is the old TRS, a reminder of where it all started. And now that Averill has finished the EMT training, he might be doing a little bit more than just computer work for the Hudson EMS!

The addition of an IBM PC to Averill's work inspired broader, more powerful applications to my EMS work. Using currently available software, we can set up in hours data tracking programs that used to

require several weeks to get up and running. We have recently completed a list of over 40 items to be tracked on each run report. The list will enable us to give precise answers to matters we have previously only wondered about. By tracking rescue calls and their locations, we are able to identify dangerous intersections, such as Terex and Hudson Drive. By adding in the time of the call, we can tell whether the safety problem is primarily one that occurs at night, on weekends, or both.

The same tracking system will be used to follow response times in relationships to call locations. Since, in many cases, the response time of an EMS is so critical to the outcome, we need to know when and if response times are prolonged. If a rescue squad is routinely taking 10 minutes to arrive at calls in any given area, and if the frequency of calls from that area is increasing (as sometimes occurs when a new development is built up), it may be time to start planning a second station from which to base another squad. When faced with a situation like this in the past, we've been limited to surveys of portions of data that may or may not accurately reflect the situation. With our new tracking system, we are able to provide a precise picture where previously only a vague impression existed.

### **The EMS Drug Book**

The practice of medicine in the prehospital setting by nonphysicians is essentially different from hospital or office-based medicine. We have used the PC to help us make some helpful adaptations. For example, powerful drugs used to correct erratic heart rhythms or to maintain the blood pressure of a patient in shock are administered intravenously in carefully measured amounts. These drugs are so powerful that the dosages, often involving only tiny volumes of fluid, must be administered carefully. In the hospital, infusion pumps are routinely used to provide exact dosage regulation; the amount to be administered can be dialed into the pump's controls. In the field, dosage regulation isn't so easy.

Infusion pumps are not available in the field; the paramedics work anywhere a victim is found. There aren't any electrical outlets in the middle of a street or on a lawn. The administration of a powerful drug in an intravenous drip becomes a much more complicated task than it is in

the hospital. We used the PC to make the task easier.

Take the administration of dopamine as an example. Dopamine is a powerful vasopressor, a drug that can help maintain or elevate blood pressure in patients in shock. The dosage administered is determined within narrow limits, based on the patient's weight. A starting dose would be 5 micrograms for every kilogram of body weight infused per minute. Tables that determine the volume to be administered per minute or per hour are usually available. If you're using an infusion pump in the hospital, all you have to do is look up the volume to be delivered, dial in the figure on the infusion pump, and you're all set. In the field, you must first calculate the volume to be delivered, the drip rate, and then the correct number of drops per minute. And don't forget to figure in the number of drops per cubic centimeter for the administration set you're using; some drip at 10 drops per cc, others at 60.

Even under the best of circumstances these calculations may be a little bit rough. But in the circumstances of a cardiac arrest resuscitation, calculation may be next to impossible. The solution that came to us was simple. One year ago, we published *The EMS Drug Book*, a locally distributed, pocket-sized pamphlet that contained actual drip rates that paramedics could use to regulate intravenous administration sets. The actual drip rates, in drops per minute, are given in tabular form for a variety of drugs in different

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dilutions and dosages. In an emergency the paramedic could refer quickly to the appropriate table and set the drip chamber regulator accordingly.

The tables were simple to use, but coming up with them was far from simple. The



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EMS Drug Book provided dosage information for 14 different drugs. Calculations had to be made to provide guidance in a variety of circumstances, including patient weight categories, differing dilutions of intravenous solutions, and different dosage strengths used to achieve different

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**W**HAT HAD  
*once taken me 3 days  
now took 15 minutes.  
And, the calculations  
were error-free.*

---

effects with the same drug. When this book was first published, it took me 3 days to do all the calculations by hand (meaning with a hand-held calculator). Tables for each circumstance in each drug category were set up and individual calculations were made and then entered by hand. They were checked and double-checked; small errors can produce major clinical problems.

The PC has changed all that. The first software I purchased after DOS 1.1 was VisiCalc and it wasn't long before I was able to enter the formulas necessary to generate the drip rates. What had once taken me 3 days now took 15 minutes. And, the calculations were error-free.

### A Research Tool

I'm also using my PC to pursue a number of EMS research projects, one of which involves using simple data analysis to determine proper field procedures for cases of head and neck injury. Cervical fractures and cervical cord injuries are a major cause of disability and paralysis following head injury, especially in motor vehicle accidents. It is an unfortunate fact that improper handling of accident victims can, and quite regularly does, convert a purely orthopedic bone injury of the cervical spine, into a neurological injury. The patient with a fractured neck bone may have no injury to the cervical spinal cord when first seen in the field, but if the head is manipulated improperly, the sharp edges of the fractured bones can slice into the soft spinal cord producing needless,

irreversible nerve damage. A person with a broken bone can be converted into a permanent quadriplegic in a matter of seconds.

All EMT's are trained thoroughly in the proper techniques for immobilizing the neck in cases of head injury. With the neck properly immobilized, further injury will not occur as victims are removed from their vehicles and transported to the hospital. Cervical immobilization techniques involve wrapping a rigid or semirigid collar around the neck while another person holds the head still. If the victim is sitting in the car, the next step is placing a specially designed rigid, short board behind the victim. The board's straps and buckles fasten the victim firmly and provide rigid immobilization during the subsequent extrication. Although these methods provide excellent protection against unnecessary cervical movement and injury, there is a major drawback: They are difficult to perform in the cramped interior of a vehicle, and they are time consuming. And time is always at a premium in the management of a trauma victim.

Why is time such an important factor? After all, if improper handling might result in paralysis or death, what could possibly be more important? Nothing, except that most of the carefully immobilized accident victims turn out to have no cervical injury at all. Some turn out to have other critical life-threatening injuries requiring immediate hospital treatment.

A driver who strikes his head on the windshield, breaking the glass, is very likely to have also struck his chest or abdomen on the steering wheel, causing a punctured, collapsed lung or a ruptured spleen, either of which can lead to a sudden death. The EMT is faced with a dilemma. If the necessary time is taken to effectively immobilize the neck of an accident victim who has sustained serious internal injuries, the delay in extrication may result in further deterioration. If, on the other hand, the EMT rushes extrication without adequate cervical immobilization, and the victim actually does have a serious neck injury, permanent nerve damage may result, rendering the victim crippled.

Valid indicators that will tell the EMT which patients are at particular risk for a serious neck injury have not been defined. At first, this might seem difficult to



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---

believe. Can't the EMT identify a serious neck injury? If cervical cord injury has already occurred, and paralysis or other gross signs of disability have set in, the injury will be apparent. But what about those victims who have not yet suffered any damage to their spinal cords? Shouldn't injury to the cervical spine be obvious? The answer is no.

One young fellow I saw in the emergency room of Akron City Hospital had struck his head while diving at a Fourth of July pool party. The next day, his neck began to bother him badly and he walked into the emergency room to be examined. An X-ray revealed his neck was broken. Another young man lost control of his motorcycle and crashed off the road one night. He picked himself up and walked home where he called the local EMS to come to his assistance. He was brought to the



emergency room, where an X-ray indicated a broken neck. These examples serve to illustrate why cervical immobilization is done whenever there is evidence of head injury. Under our present operating protocols, any accident victim who has any sign of head or neck injury undergoes full immobilization measures. At this time, there is simply no safe alternative. For example, whenever we find that the driver of a car involved in an accident has broken the windshield with his head, the neck is immediately immobilized. Even if the driver states there is no neck pain, he may have had a concussion and be incapable of perceiving pain accurately.

Given the large number of victims who turn out to have no cervical injury at all and the amount of time that cervical immobilization takes, we wondered if it was possible to identify those victims most likely to have cervical injuries. We set up a research protocol that uses both data analysis and information management capabilities of the PC.

First we made a list of "prehospital

assessment data," findings that might be associated with, or indicative of, serious neck injury, and put them into a form that could be used for data collection. This

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form, rapidly created using Volkswriter and the PC, includes three different kinds of findings. The first is situational, data associated with the mechanism of injury itself. Included in this group are types of accidents—falls from ladders, falls from

roofs, diving accidents, motor vehicle accidents—that produce most of the serious neck injuries we see in the hospital. The next group consists of subjective findings, information the victim reports to the EMT, such as neck pain ("My neck hurts.") or abnormal neurological sensations ("My arm feels numb."). The final group consists of objective findings discovered by the paramedic during the physical assessment, such as pain on palpation (POP) of the neck, or decreased sensation.

Then we identified the Hudson EMS run reports involving persons who underwent cervical immobilization by the squad. Once these reports were identified, the information in the "prehospital assessment data" section was complete. Along with some basic key data, this would enable us to complete the next phase of data collection. That phase concerns the outcome. We made a list of "outcome" data that would enable us to distinguish those patients who turned out to have serious neck injury from those who

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did not.

We first used the EMS run reports to identify patients and the hospitals to which they were transported. This also enabled us to complete the "prehospital assessment data" for each report studied. At this time we are using the information from the EMS run reports to direct us to the hospital and emergency department records that will provide the "outcome" data we need.

As these data are collected, they are entered on a Lotus 1-2-3 worksheet designed to facilitate data analysis. Since 1-2-3 also has information management capabilities, data is entered in the form of records, one per patient, with each finding listed in the appropriate field. The DATA commands then make short work of any questions we have about existing patterns in the data, such as the age of patients with serious injury, and so forth.

Once we have collected enough data to provide a statistically significant sample, a formal statistical analysis will tell us whether we have identified any prehospi-

tal assessment findings that can be used as valid predictors of serious neck injury. It's too early to say just what we'll find, but we are hoping to produce some good hard data that will enable our EMS units to dis-

## **T**ENS HAS *found a rather firm place in the area of postoperative pain.*

pense with cervical immobilization unless certain key findings are identified. This will enable them to deal more rapidly with head-injured patients, especially those involved in car accidents.

### **Pain Control in the Field**

In a totally separate research project, I used 1-2-3 to rapidly predict just how dif-

ficult it would be to collect data for a study. A physician colleague who works with another EMS unit in our county told me he wanted to investigate the field use of a pain control device called a Transcutaneous Electronic Nerve Stimulator, or TENS. This tiny device, about the size of a tape cassette, sends electrical currents to electrodes, which are placed on the body surface by means of small adhesive pads. Although the TENS is a relatively new weapon in the physician's armamentarium of analgesia, it has found a rather firm place in the area of postoperative pain. Placing the electrodes on both sides of a surgical incision has been shown to reduce the need for narcotics postoperatively. It has also been used to control other kinds of chronic pain, such as that resulting from nerve injury, which has been resistant to many forms of treatment. Could this device, my colleague wondered, be used successfully by our EMS personnel? And if so, how could we go about finding out?

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pain control in EMS is certainly very attractive. The popular image of the army medic quickly injecting morphine into his injured comrade is a far cry from the reality of civilian EMS. The means of dealing with pain in the prehospital setting are rather limited. In fact, strong narcotic analgesics are the last thing a critically

## IT'S NO surprise to me that my colleague chose the IBM PC.

injured-patient should receive. Shock from blood loss lowers blood pressure, and morphine, which also causes the blood pressure to drop, can be the final, fatal insult to a person whose blood pressure is already dangerously low. Furthermore, the administration of morphine can produce drowsiness or even unconsciousness, hopelessly blurring the signs the physician must use to assess the presence, degree, and progression of head injury. A critical sign used to assess the extent of head injury has been lost.

But most of the injuries seen by squad personnel are not this severe. Broken ankles, broken hips, burns, the "road rash" acquired by the motorcyclist skidding along the highway on his back, are the most common fare of our EMS. In cases of arm or leg injuries, careful, secure immobilization with splints and bandages provides a modicum of comfort and relief. But in many cases, the pain persists, aggravated by the bounces and bumps of even the most careful ambulance transport to the hospital. Might TENS be useful in this setting?

I advised my colleague to investigate this question in the format of a formal research project. He suggested the use of TENS in an unorthodox setting. The projected EMS application for TENS was so different from its current uses that the risk factor had to be considered. Might its application, for example, interfere with proper immobilization, or unnecessarily delay transport to the hospital?

The research format was agreed upon, and my colleague set out to design the

project. One of the problems he encountered was the low availability of subjects. How long, I asked him, will it take your squad to see enough victims for whom TENS might have a potential use? Obtaining a valid sample would be time consuming. To help him through this part of the planning, I called upon 1-2-3 and a series of 100 consecutive rescue calls from one of my squads. The research protocol called for the use of TENS only in cases of nonlifethreatening trauma. Each of the 100 run reports was examined to see whether or not TENS would have been offered. Of the 100 runs, I found that 10 met the criteria. The rest was easy. A simple table was set up using 1-2-3's Date functions. The dates of the first and last of the 100 runs were entered, and the difference calculated. This gave us the number of days required to generate 10 runs that could be used in a TENS study.

How many days would it take to collect 100 cases? We set up a WHAT-IF table and got a very quick answer: 480 days. But this was for one of my squads. How about for my colleague's squad, where most of the research would be done? The squad I had used to analyze those 100 consecutive reports, the Tallmadge Fire Department, served a population of over 15,000 people and was considerably busier than the Copley Fire Department, which served a population of under 10,000. Would we have to

do the whole study over? The answer, fortunately, was no.

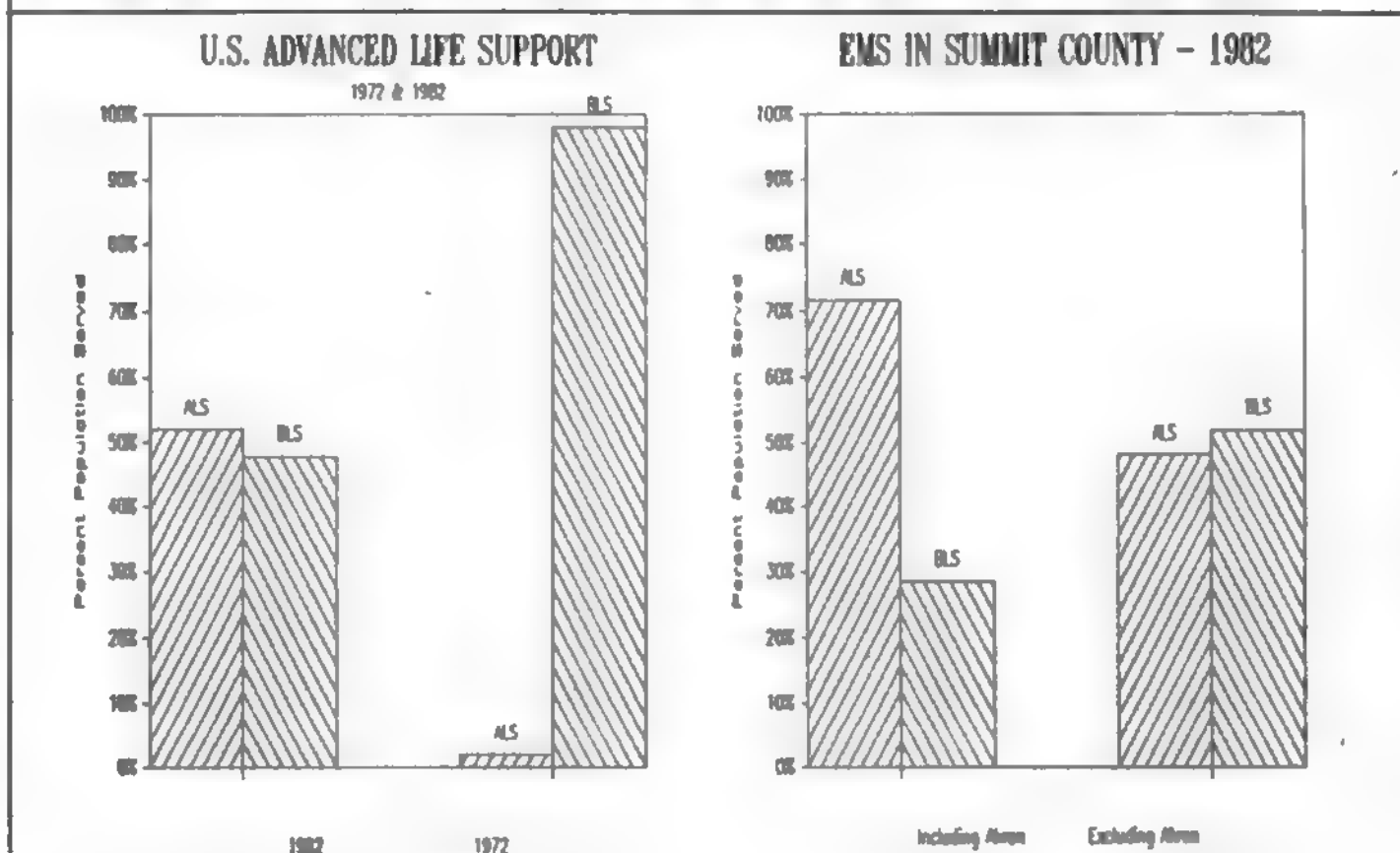
Although Copley is smaller, the kinds of problems seen by its EMS are almost identical to those seen in Tallmadge. We set up another table, using the annual run totals for each squad. Since we knew how many TENS runs would be collected from 100 squad runs how long it took Tallmadge to generate 100 consecutive runs, it was a simple matter to set up the table to tell us how many days it would take Copley to generate a sample of 100 TENS runs.

The study was approved by the hospital research committee and is now in progress. That was 3 months ago. And guess who bought himself a personal computer last week? It's no surprise to me that my colleague chose the IBM PC.

### The Newest Specialty

The rapid growth and advancement of EMS capabilities in this country has of necessity been paralleled by the growth of emergency medicine as a specialty. At one time, just as an accident victim's fate often depended on who, if anyone, came to the rescue, the subsequent treatment in the hospital depended on who, if anyone, was in the emergency room. In many hospitals, physicians on the staff, regardless of specialty, training, or experience, would take turns rotating coverage for the emergency

Figure 1: Two examples of simple but relevant tables generated as part of the emergency medical services study conducted by the author. The table on the left contrasts the nationwide availability of basic life services and advanced life services in 1972 to their availability in 1982. The table on the right shows how inclusion of the City of Akron skews the percentage of emergency medical services in Summit County, Ohio.





room. This meant that in hospitals that did not see many emergency patients, the patients would see a nurse in the emergency room, who would phone the doctor at home to determine the treatment, and whether or not the doctor would actually come to the hospital. Even in busier locations, where doctors were always present, quality of care often suffered from a mismatch of patient problems and physician skills; a surgeon would treat a severe asthma attack, or an internist would be confronted with a badly injured accident victim. The growth of emergency medicine, the country's newest recognized specialty, is changing that forever.

In 1979, 10 years after the formation of the American College of Emergency Physicians (ACEP), the specialty of emergency medicine was formally recognized by the American Board of Medical Specialties and the first series of board certification exams in emergency medicine were launched. More and more emergency rooms around the country have been transformed into emergency departments staffed by emergency physicians, specialists trained to provide optimal care for the vast array of problems presented by the sick and injured who pass through the hospital's doors. The relationship between emergency medicine, emergency physicians, and EMS has been similarly transformed.

Emergency physicians have come to enjoy a special relationship with EMS personnel, providing the interface between field and hospital. It was only natural that ACEP should commit itself to the training and direction of EMS personnel. In addition, an emergency physician's training and practice must include some interaction with EMS. For example, at Akron City Hospital, where our Emergency Medicine Residency Training Program enjoys a reputation as one of the best in the country, participation by our resident physicians in EMS training and supervision is mandatory.

This commitment has made Akron City Hospital EMS (ACH EMS) a buzzing center of EMS activity in our county. Several years ago, a computer might not have been necessary. Now, it's hard to imagine running the operation without it. No fewer than 15 different EMS units in this region look to us for medical direction and training. Acquiring the PC has enabled us to

to know if we were making progress. The worksheet told us.

Almost 72 percent of the county's population of over 500,000 had access to ALS, considerably above the national average. And although these figures, as predicted, were skewed by the ALS service in Akron, which serves almost half the county's population, using a few quick WHAT-IFs on the worksheet told us that we were still close to the national average, even without Akron's figures.

Since that analysis was made in early 1983, two changes have occurred. I've moved these calculations to a 1-2-3 worksheet, which enables me to analyze ALS versus BLS capabilities more easily through the DATA, SORT and DATA, QUERY commands, instead of first separating figures into separate columns for ALS and BLS, as I had to do with VisiCalc; 1-2-3 also provided me with the graphic representations of these percentages (see Figure 1).

The other change in the worksheet occurred in the southern end of Summit County, in Green Township.

### Changing A to B

About 2 years ago, firemedic (firefighter/paramedic) David Calderone of the Green Township Fire Department visited me in my office and spoke a few words that sounded awfully familiar: "We want," he said "to upgrade to Advanced Life Support. And we want to be the best."

It was a long haul, involving countless hours of training and planning, but on May 15, 1983, Calderone's dream came true. The ALS EMS of the Green Township Fire Department went into service with 12 full-time firemedics. When that happened, I changed the BLS next to "Green" to ALS on my 1-2-3 worksheet and watched the other numbers change (see Figure 2). We had surpassed the national average of 52 percent ALS, even excluding Akron's population from our figures. Not bad!

By the time you read this, the picture may have been altered again. Paramedics with the tiny Valley Fire District are busy planning for the time when they can implement ALS, and the city of Norton is on the brink of doing the same.

When that happens, I'll simply change a "B" to an "A"—and watch all the numbers change.

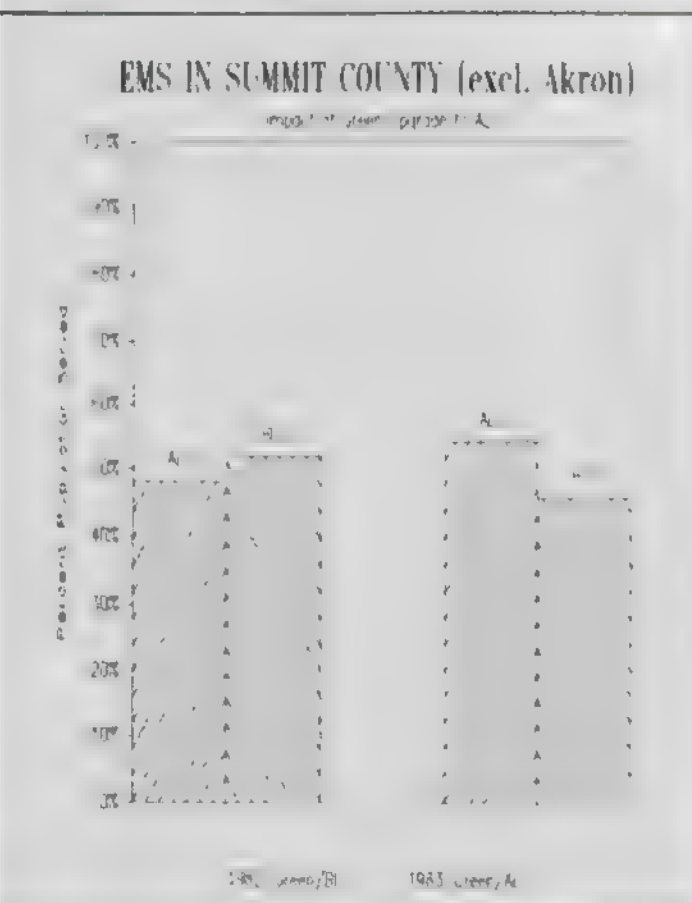
/PC

## *PARTICIPATION by our resident physicians in EMS training and supervision is mandatory.*

fully grasp the extent of our work, and to define ourselves as part of a larger nationwide emergency medical service network.

The very first week I put my PC into operation, I was busily plugging population figures into a VisiCalc worksheet, learning the commands as I went along. Population figures and EMS capability for each municipality in Summit County were entered. We knew that just over half of all the people in the United States had access to Advanced Life Support EMS, and that this figure was probably skewed by the fact that 92 percent of people living in cities with populations over 150,000 were served by ALS. But what we didn't know was where we stood. ALS cannot happen without physician participation, guidance, and direction. Our work in this arena had been extensive and we wanted

Figure 2: The effect of upgrading emergency medical services in Green Township on Summit County as a whole.





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Peter Norton has lifted the shroud that hides the secrets of the IBM PC with his new book, *Inside the IBM PC*. It reveals the inner workings of the computer and shows programmers how to take advantage of the many features of the PC. Much of this book applies not only to the PC, but also to PC clones and to other computers that function under MS-DOS.

Peter Norton is the fellow who stares at you from the ads for his *Norton Utilities* with an arms-folded, Superman stance. His pioneer *Utilities* provide the ability to

modify data on disks, recover erased files, and conjure up miscellaneous magic with the computer. Norton has also authored articles on the workings of the IBM PC and approaches to programming it in Pascal.

Although Norton is as gentle as he can be with beginners, his subtitle signals that the book is for more experienced users: *Access to Advanced Features and Programming*. This is what his book is all about. With Norton's helping hand, you can learn the location of the PC's internal routines and how to make use of them for your own programs.

Norton explains how hardware is designed around the Intel 8088 central processor. He tells how its registers work and how it relates to the rest of the computer and the outside world through its ports. Norton shows how the read-only memory (ROM) of the PC is allocated to such purposes as BASIC and the basic input-output

system (BIOS). He maps the random access memory (RAM) for functions such as the monochrome- and color-monitor displays, and he speculates on the future of the PC based on the location of unused memory.

## PC Routines

As you read about the inner workings of the PC, Norton invites you to tag along by using the program listings he provides. His Assembler, Pascal, and BASIC source-code listings give you access to many of the PC's routines. These help you crack the code of the PC as you read the book. They also serve as the bare bones of your own program routines.

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the directory, file allocation table, and boot sector.

He briefly describes the primary file types such as text and data, COM and EXE. Using Debug, he shows how a program is put together by taking it apart, and how to snoop through the ROM with it.

Inside the IBM PC is a treasure map to all of the golden routines buried within the PC, for the real gems of the book are in the access of built-in routines. These are in the ROM and are called by the PC's interrupts. Norton shows you how to do this.

A partial list will whet the appetite of any programmer: You can use the DOS service routines to capture the Control/Break combination, and read or write disk sectors. Other routines get characters from the keyboard or RS-232; echo to the screen; send bytes to the printer or RS-232; set the default drive, open, close, erase, read, or write a file; parse a file name for a file control block; read or set the date and time.

With the ROM BIOS services you can reset the drive, format a track, find a disk-error code, read or write entire tracks; set foreground and background colors; select the 40- or 80-column mode in text or graphics with or without color, or choose the monochrome display. The cursor size may be set or moved, and its location read. You can read the light pen position, switch the active page of video, scroll the display up or down, write a character and its attribute to the screen, or read what's there.

It's true that much of this information may be exhumed from the *Technical Reference Manual* by those who speak IBMese, but Peter Norton has made a clear translation and has added a great deal that IBM never told us.

## Key Tricks

Have you ever wished there were 40 function keys on the PC instead of only 10? Norton shows how your programs can use combinations of the function keys with Alt, Ctl or Shift to provide 40 special functions.

It's through the keyboard that the computer communicates with its operator, and Norton gives us a new bag of tricks to help. He shows how the special Insert, Caps Lock, Num Lock, Scroll Lock, Shift, Alt, and Ctl keys can be intercepted. He explains the Ctl/Alt/Del and Ctl/Brk key

routines, together with a means to tell if keys are repeating or if they have been released.

Norton explains how to generate up to

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128 custom graphics characters, which can be displayed in your program as easily as letters of the alphabet. This is one way that the PC could be adapted for use with Greek, Russian, or Japanese or made to perform special graphics functions quickly and easily.

Norton gives us the key to activate the Print Screen function from BASIC and shows how to take advantage of the PC's built-in speaker and take control of the IBM clock.

## An Indispensable Manual

Norton explains how to set resident routines that won't be stepped on by other programs loaded from DOS and how these can be integrated with the new program. He shows how to write a copy-protected disk to foil computer pirates, and summarizes the codes to get the most out of the IBM/Epson printer.

At the end of *Inside the IBM PC*, Peter Norton gives his readers a gentle shove to get them started in IBM's assembler language. He shows us how it can be integrated into Pascal and BASIC programs to provide access to all of the PC's power.

An option offered with *Inside the IBM PC* is a disk of sample programs written as a companion to the book and containing all of the programs listed in it. In addition, the disk includes one of the stars of the Norton Utilities series, DiskLook, which permits you to see the data in any disk or file sector.

Norton has written *Inside the IBM PC* in a clear style that is simple to follow despite its technical nature. With this book he has opened a whole new world of programming and put the full power of the IBM PC within reach. Every serious programmer of the PC is sure to find space for Peter Norton's book right next to the DOS manual.

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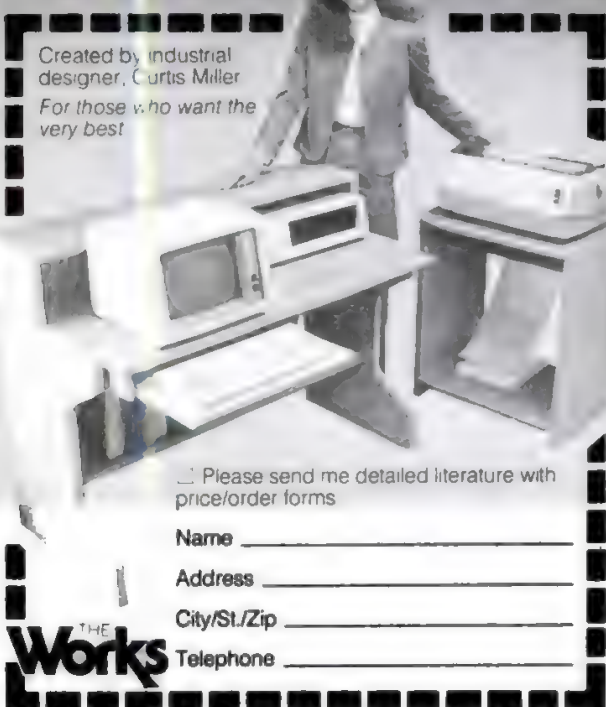
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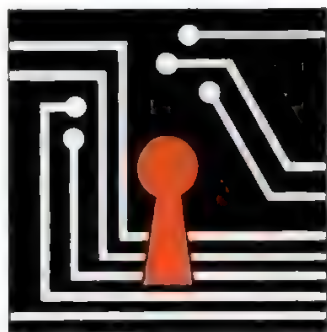


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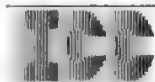
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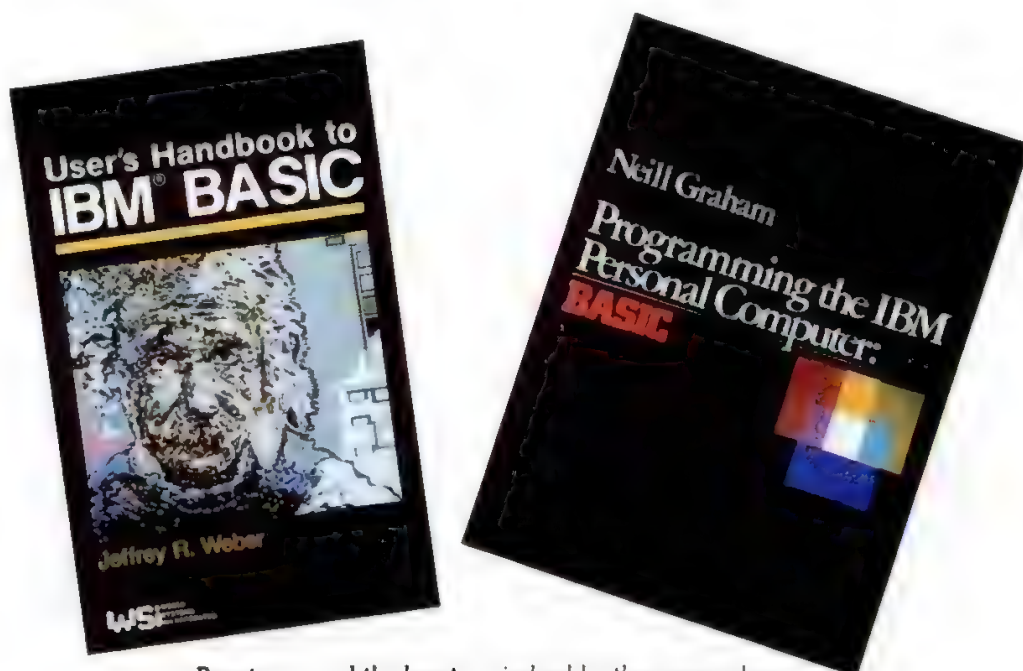
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*Beauty . . . and the beast, as judged by the covers alone.*

# Two Basic Alternatives for Learning IBM BASIC

**Programming the IBM Personal Computer: BASIC**

Neill Graham

(CBS College Publishing, New York, 1982)

291 pages; \$17.50

**CIRCLE 794 ON READER SERVICE CARD**

**User's Handbook to IBM BASIC**

Jeffrey R. Weber

(Weber Systems, Inc., Cleveland, OH, 1982)

309 pages; \$13.95

**CIRCLE 795 ON READER SERVICE CARD**

You're standing in the computer books section of your local bookstore trying to find something to help you learn how to program that newly purchased IBM PC. This section of the store is much bigger than it was a few months ago; there are lots of books here. From the wide assortment, you pull out the two listed above. Which one do you choose?

The problem of choosing computer books is a difficult one these days. The market is such that a book's useful lifetime lies somewhere between a few months and a few years. Consequently, the production of a book is often hurried, and unfortunately, sometimes it shows. For

instance, the last half of a book might be crammed with tables, pictures, or anything else that appears to be useful and for which reprint permission can be obtained easily. Neither of these books is guilty of such blatant padding, although one of them does duplicate information you will already have access to if you own a PC.

On the other side of the equation, the buyer usually has precious little to go on when selecting a programming book. Presumably the prospective purchaser doesn't know enough to judge the book's merit. And even with knowledge, it's hard to make a decision in just a few minutes in a crowded bookstore. Sometimes an intel-

ligent salesperson can help, but sometimes help simply is not available. I suspect that, in fact, the cover often sells a book.

To test my theory, when I got these books home I laid them on the table and waited to see how the other members of the household would react to them. With-

out exception, they went for *User's Handbook* first. Maybe a book shouldn't be judged by its cover, but plenty of them are. This book is shorter but thicker than the other one. It fits well in the hand. The cover sports an apparently digitized picture of Einstein. It looks official and reeks of computerese. And if none of this impresses

you, those sad beagle eyes just beg you to "buy me."

*Programming the IBM Personal Computer: BASIC* in contrast, exhibits just about the plainest cover you're ever likely to see: a simple color design on a mostly black background. If you take the time to appreciate it, it looks nice enough but isn't going to attract the eye of browsers, which is a pity, as Neill Graham's *Programming the IBM* really is the better book.

### Programming the IBM

This book starts out gently. The introduction urges you to experiment with your computer, reassures you that you can't do permanent damage by typing at the keyboard.

Nothing is assumed about the user's experience with computers. Chapter 1 begins with a description of how to turn on the computer and start BASIC. The author recommends at the outset that readers keep their PC manuals handy. Book space is not wasted by reproducing illustrations and tables that can be found in the manuals.

Throughout the book, BASIC concepts and statements are illustrated with programs, most of them short enough to be entered and tried as you read. Almost every page has at least one short program. They are well written and easy to read. Most are in full-sized green print.

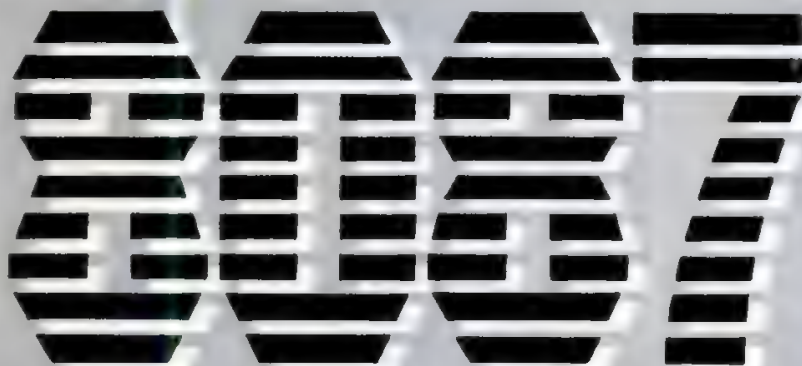
The first program the reader comes to begins

```
10 PRINT "Greetings from your
computer."
```

If this is too easy for you, be patient. The programs do more than just illustrate concepts; some appear to be useful and/or entertaining in their own right.

For instance, there are four well-written pages on sorting methods, including an example of Shell sorting (an efficient sorting method named after its inventor, Donald Shell). There is also a fairly complicated text editing program that illustrates string operations. A binary search routine is also included. The book contains separate chapters on serial and random files. The latter contains an information-retrieval program that illustrates both types of files. And, for the frivolous, there are even a couple of game programs.

The book also covers the usual things you would expect in a volume on BASIC



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programming—chapters on data types, variables, loops, functions and subroutines, formatting, strings, event trapping, and graphics.

The organization is a bit unorthodox but nonetheless effective. For instance, the chapter titled "Repetition" explains not only FOR-NEXT and WHILE-WEND,

by clarity and completeness. The author obviously understands his subject and presents it in a clear, reassuring style.

#### User's Handbook

Part of the problem with *User's Handbook to IBM BASIC* is that it uses a great deal of space to give information that

you'll either already have if you own a PC or won't need to know. For instance, the book begins with a hardware and system description. There are pictures of the computer (you know what it looks like), disks (you know what they look like), the system board, and so forth. There are tables (CPU characteristics, BIOS interrupt vec-

**I**F YOU  
write your programs for  
others, detection and  
trapping of input errors  
is a very desirable  
feature.

but also READ and DATA, which also usually involve repetition. And the chapter on event trapping contains a section on the PLAY statement, located there because MB (music background) is a type of event trapping. There are, however, no programs for light pens or joysticks, which also use event trapping.

An important chapter to include in any introductory programming book is one on designing and debugging your program. This book includes such a chapter, with good advice about modularity of construction, avoiding unconditional jumps, and testing and debugging. Top-down design using structured routines is advocated as an approach to minimize bugs and promote understanding. Anyone who has had to dig out a year-old program to debug or modify should appreciate this. Bug finding with TRON is covered, and the author points out that if you write your programs for others, detection and trapping of input errors is a very desirable feature. "Redo from start" must be the most frustrating prompt ever devised.

Most of the chapters end with a set of exercises, but many readers won't bother with them unless they are using the book as part of a course. The exercises, however, appear to be well designed and will reinforce the reader's understanding of the concepts and techniques presented in the chapter.

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tor functions, RAM and ROM characteristics), and a brief description of the operating systems. None of this is of much help to the neophyte BASIC user. The most useful introductory information is duplicated from the manuals that came with your PC.

Useful information about BASIC pro-

gramming starts in Chapter 2. Topics are covered rather hastily, as only 93 pages have been allotted. If you already know BASIC, these 93 pages might suffice as an introduction to the IBM version. Most of the topics that the previous book covers are also found here. The difference is that the information is compressed and not

nearly as well-illustrated. Only a few short programs are included, and none are particularly useful. Examples and problems at the ends of the chapters are also missing.

Chapter 2, "Introduction to IBM BASIC," lists the different versions of IBM BASIC, explains how to enter a program from the keyboard, and discusses variable names and types. The next chapter, "Beginning IBM BASIC," gets into BASIC statement structure, mixing variable types, precedence of operations, relational operators, input and output, conditional statements, and branching. But everything goes by too quickly.

"More BASIC Concepts," Chapter 4, includes tables and arrays, subroutines, advanced printing concepts, RND, strings, functions, graphics, and logical operators. The advanced printing section omits the ! and \n spaces\ string fields. Like most others, this section is better handled in Programming the IBM.

However, the User's Handbook coverage of logical operators is superior to the equivalent section in Programming the IBM. There are several tables that show the effects of the logical operations available on the PC, bit by bit.

Chapter 5, which purports to be about files and file handling, spends more than half of its space covering DOS diskette operations, such as how to copy your DOS diskette and verify it with DISKCOMP. There's even a full-page picture of a 5¼-inch diskette, as if the half-page picture on page 33 were not enough.

Chapter 6, "Advanced Concepts," has seven pages of explanation about the program editing keys, but half of the chapter consists of tables containing information available in the BASIC manual. Finally, there is a single page about TRON and TROFF, but that's it.

A reference guide with appendixes occupies the second half of the book. The guide describes the BASIC statement set for the PC. Nearly everything in these sections can be found in the BASIC manual, so IBM's software documenters have nothing to fear from Mr. Weber on this score. His documentation is neither noticeably better nor worse than IBM's. I do find the IBM manual ergonomically superior, however. It stays open when you put it down. If you like to type with both hands, this is a benefit not to be sneezed at.

Still, User's Handbook is acceptable as

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an alternate set of BASIC statement documentation for the PC. But, if you want to learn about BASIC from the beginning, and about good programming practice, you will be better off with *Programming the IBM*.

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#### Omissions and Errors

The PC is much less of a static system than, say, the Apple or TRS-80. Improvements come along every year or so, the cause of serious heartburn to writers and publishers. Any book in such a rapidly moving field stands a chance of being out of date the day it is published. Both of these books suffer, at least slightly, from this problem.

You won't find anything about BASICA 2.0 in either one. Both were written when DOS 1.0 was the standard. *Programming the IBM* does contain some notes, apparently added in the final stages for DOS 1.10.

There is not much about graphics in either book. If your interest lies in this area and you already know how to program in BASIC, neither book would be a good choice, especially since most of the Version 2.0 enhancements to BASIC deal with graphics.

Probably every programming book ever written has at least one bug or printer's error. I found a few in *User's Handbook*. On page 111, the CSNG function is printed as CSGN. This is particularly unfortunate, since the SGN function is discussed just above it. My son, who went right to the good stuff, found that the example for PLAY, on page 248, doesn't work; there are two fatal mistakes in this three-line program. You won't find either one of them unless you know something about music. But I'll leave you with a hint: Did you ever try to play an L#? /PC

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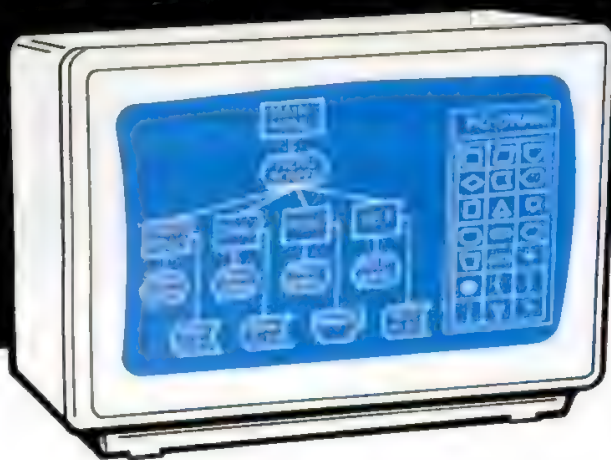
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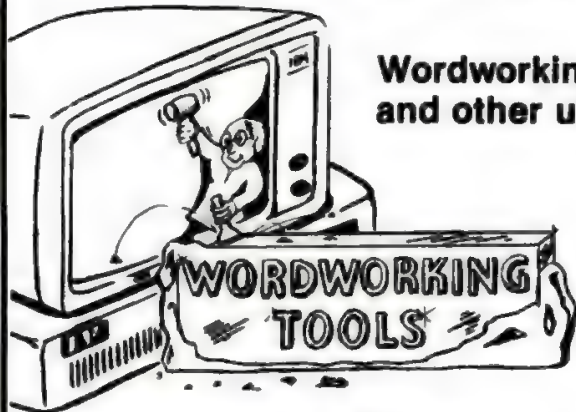


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Evolution is a higher game form. This is a very clever, well designed game that may mark another step in the evolutionary chain from Pong, past *Space Invaders*, and into worlds yet unimagined.

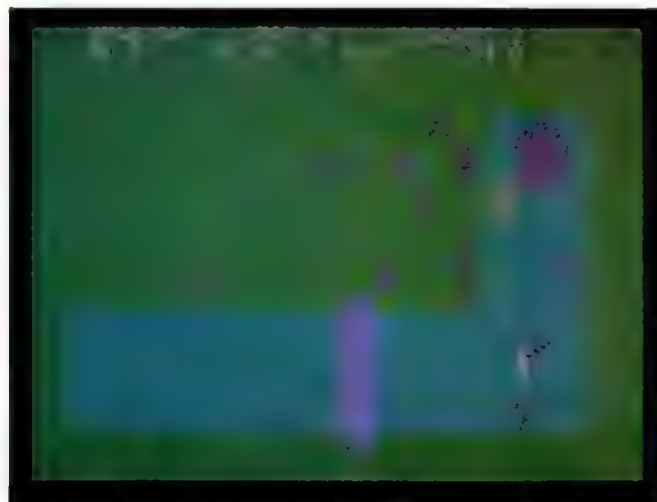
Okay, it should be obvious that I like this game. I don't want to get too carried away, though; it is still a silly little diversion, but there is such obvious attention to detail and imagination in this product that it earns a high ranking on the Dar-

winian chain.

There are six different challenges in this game, with three levels of difficulty. It can be played from the keyboard or with a joystick; I recommend the joystick. The game requires a color/graphics monitor and displays gorgeous, finely crafted images on an RGB monitor. The sound effects are well done, and each of the six screens includes its own bit of theme music.



Monster to the left, monsters to the right, an asteroid above, and the darkness of space beyond in *Space Miner*.



Lining up for a drive down the dog leg back nine on *Golf Challenge*.

So, on to the game of *Evolution*: You start out life as an Amoeba. Maneuvering around in a liquid medium, you try to eat DNA cells. Unfortunately, life as an Amoeba is not limited to mere grazing: You are pursued by spores, microbes, and antibodies. This is not a maze game, and the attackers do not follow predictable paths. You must elude your attackers, but as an Amoeba, you have a limited number of shields to provide temporary safety. But with luck (and practice) you eat all of the DNA, and it's time to move up to the next level.

As a Tadpole, you are a cute little fellow running back and forth at the bottom of the screen. You can go left or right, or you can jump. Your aim is to snare one of the elusive fluttering water flies without being caught in the jaws of hungry fish.

If you eat your quota of three flies, you become a Rodent. Here you burrow around in an unmarked cave, making your own maze. Your aim is to eat wedges of cheese that appear in the tunnel behind you; your challenge is to avoid speedy

snakes racing around looking for you. You can kill a snake by dropping a pile of dung, but you have only three passes at that defense. When you manage to eat five

## ***E**volution earns a high ranking on the Darwinian chain.*

cheeses, its on up the ladder.

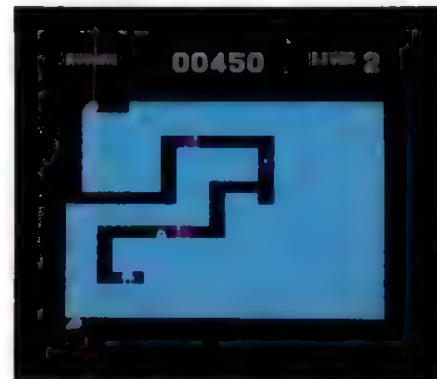
Now you are a Beaver. On the right side of the screen is a stack of sticks. You're on the left and between you and the sticks is a river full of alligators. Your assignment is to swim across (without getting yourself caught by the alligators' gaping mouths), retrieve the sticks, and build your dam. Harder done than said.

The next step is that of a rare orange Gorilla. You must protect three oranges from thieving monkeys by throwing coco-

nuts at them and dislodging them from the trees. This stage is surprisingly easy, but it serves as a breather before the "highest form of evolution."

Here, alas, *Evolution* takes a turn toward the mundane. (Or maybe it is merely that humankind is so predictably hostile.) Anyhow, the Human level of *Evolution* is a shoot-em-up in space: You against the genetic mutants. It is a well-designed segment nevertheless, with the additional fillip of having to avoid the ricochets of your own shots as you maneuver around the screen.

The copy-protected game presented no problems in operation, although I was disappointed to find that I could not escape to the operating system by command or even by using the Ctrl-Alt-Del combination. The only way out of *Evolution* is by shutting off the power. Within the game, you are able to shift from keyboard to joystick, toggle the sound on or off, cut short the musical interludes, and display high scores. You can also jump from the opening screen to any of the six levels for reme-



Arcadian evolution: In the game, *Evolution*, life begins as an Amoeba and advances to Tadpole, Rodent, Beaver, Gorilla, and Human. This history of life is fraught with peril.



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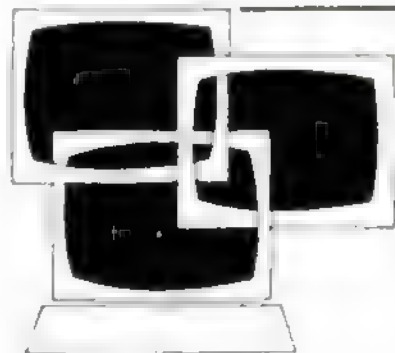
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CIRCLE 435 ON READER SERVICE CARD

dial practice.

I don't know if this is exactly what Charles Darwin had in mind, but this game might have made Clarence Darrow's case a lot stronger in the Scopes Trial.

On PC's scale of one to six, *Evolution* ranks as follows:

FUN:	5
CHALLENGE:	5
GRAPHICS/SOUND:	5
TOTAL SCORE:	15

**Space Miner**

Resolution Software  
8 Edgewood Blvd.  
Providence, RI 02905  
(401) 461-2417

**List Price: \$29.95**

**Requires:** 64K RAM, color/graphics adapter, color or monochrome monitor. Joysticks and game adapter optional.

CIRCLE 792 ON READER SERVICE CARD

Stuck in space again, pursued by gobbling monsters and chasing after elusive asteroids, energy clouds, and other objects? Welcome to *Space Miner*, another version of the shoot-em-up in space.

There are, however a few surprises in

## *F*RANKLY, I'd rather watch the grass grow.

this game, including an opening theme of the *Goldberg Variations* by J.S. Bach, and some pretty graphics. The attacking monsters are huge grinning faces that gobble right through your ship when they win a round. Your ship is equipped with two tools: a claw-like device to grab things and a set of rocket launchers to shoot the aliens (hit one and his face turns from a grin to a scowl). One other nice graphics touch is the 3-D effect of moving stars on different planes.

The game can be run from the keyboard with a bit of awkwardness. With a game adapter in place, joysticks can be used. *Space Miner* does not recognize the existence of both a color and monochrome adapter, and the owner of such a system must make the switch with his own command. There is a pause control and a



"panic" escape key to dump back to DOS in case the boss rounds the corner unexpectedly.

Space Miner scores as follows:

FUN:	3
CHALLENGE:	3
GRAPHICS/SOUND:	4.5
TOTAL:	10.5

#### Golf Challenge

Sierra On-Line, Inc.  
36575 Mudge Ranch Rd.  
Coarsegold, CA 93614  
(209) 683-6858

List Price: \$24.95

Requires: 64K, color/graphics adapter, color monitor. Joysticks and game adapter optional.

CIRCLE 790 ON READER SERVICE CARD

If you like golf, you'll probably find this game about as exciting as being trapped behind a foursome of Cub Scouts who refuse to let you play through. If you don't play golf, you'll probably find this game even less thrilling.

According to the instructions for *Golf Challenge*, "You size up the shot, you address the ball, your putter swings forward, and . . . if the angle is correct you will sink the putt; if it is not, it is just another bogey. You can control every shot on the course just as you would if you were playing in the Masters."

If that's true, you can call me Arnold Palmer. I found *Golf Challenge* to be an awkward, slow adaptation of the home video game cartridge products in which you move a little stick figure of a man around a set of 18 almost indistinguishable "holes" and swing a barely controllable club in the general direction you'd like the ball to go.

The copy-protected disk includes an option for joystick or keyboard control of the man and his club. You can select as many as four players, an RGB or composite monitor, turn the sound on or off, and choose to play all 18 holes or the first or last 9.

Frankly, I'd rather watch the grass grow. /PC

Golf Challenge rates:

FUN:	2
CHALLENGE:	2
GRAPHICS/SOUND:	2
TOTAL SCORE:	6

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MARK ZACHMANN

*Questions about correct use of filenames in PC-DOS, controlling printers from WordStar, and how to tell the difference between the 8088 and other Intel chips are answered in this session with the PC Tutor.*

# PC Tutor



## The 8088's Family

**Q:** Could you please explain the difference between the 8088 chip used in the IBM PC and the other microprocessor chips available from Intel that are labeled as compatible? Can I plug these newer chips into the PC in place of my 8088 and will this give any speed advantage?

**A:** Intel presently sells five different microcomputer chips that will run IBM PC programs. They are all different and contain properties that give them advantages. But the only chip that will plug into the PC's socket is the 8088, which is the one already there.

You are probably familiar with two chips: the 8086 and 8088. The two are completely software compatible. The only difference between them is that the 8086 speaks to the outside world over a 16-bit data bus, while the 8088 uses an 8-bit data bus.

Several Readers

When a microprocessor has to read an instruction or write data to memory (as when executing a POKE), it communicates over a data bus. By having a 16-bit instead of an 8-bit data bus, the microprocessor can transfer data and read instructions twice as fast. This does not mean that the 8086 runs twice as fast as the 8088. Rather, the total speed advantage will be more like 30 to 60 percent,

depending on the instructions used.

For example, when BASIC performs a POKE instruction, this transfers only 8 bits of data—1 byte. Being able to transfer 2 bytes at once with a 16-bit data bus is no advantage for executing the POKE instruction. Similarly, when the processor moves information between the registers on the chip, it doesn't really matter how big the data bus is, except insofar as the instruction itself is loaded twice as fast. Once the instruction is loaded into the processor, either processor will run at the same speed.

A register is a piece of very fast memory internal to the microprocessor chip. Machine language instructions almost always manipulate registers. Let's look at an example in assembler code:

```
ADD AX,AX
```

This instruction tells the processor to take the contents of the register called AX and add it to itself. (This is like the following BASIC instruction:  $X = X + X$ .) After the instruction is performed, the new value in AX will be twice the old value.

The 8088 processes this instruction in

two steps. First, the instruction is fetched from memory. In memory, the instruction actually looks like 2 bytes: 1, 192. Thus, an 8088 will take twice as long as an 8086 to fetch the 2 bytes of the instruction. Once the instruction is fetched, the processor decodes the bytes and realizes that it is being told to double the AX register. Execution proceeds at the same speed whether the chip is an 8086 or an 8088.

Actually, Intel designed the iAPX series (8086 et al) of chips very cleverly. The fetching mechanism is distinct from the execution mechanism. While the chip is executing "ADD AX,AX" it simultaneously fetches another instruction. Thus, you can almost ignore instruction fetch time in figuring execution time. You must take the time into account, though, when the processor jumps to a different location, as in a BASIC GOTO instruction.

Thus, the 8086 will run twice as fast as an 8088 when one of two things happens: when it reads or writes 2 bytes of information, or when it executes an instruction that was not previously fetched.

A lot goes on inside the 8088 chip in order to execute that "ADD AX,AX" instruction. In the same way that BASIC interprets " $X = X + X$ ," the 8088 has to interpret "1, 192." The "ADD AX,AX" instruction is the simplest instruction in the 8088 repertoire. This instruction exe-



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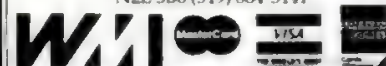
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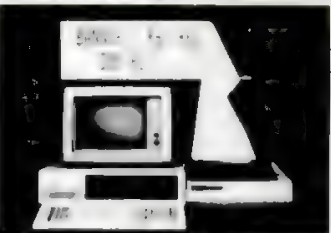
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cutes in about 600 nsec: Another way to say this is that an 8088 can double the AX register 1.6 million times per second.

A more complex instruction is "ADD AX,[12]." This instruction requires 3,000 nsec. In the 8088 and 8086, the instruction is decoded as follows: First the instruction is fetched; then 12 is added to 16 times the value of the DS segment register; finally the contents of that effective address are added to the current value of the AX register. The process would be like this BASIC instruction:

`X = X + PEEK (12 + 16*DS).`

Since the IBM BASIC does not support addressing through the full range of the PC, this would really look like:

`DEF SEG = Ds : X = X + PEEK (12).`

In the 8088 and 8086, the instruction is interpreted and the addition is performed just as shown here. In the newer chips from Intel, most of this work takes place in the chip's internal hardware, rather than in its internal software, known as micro-code.

The newer chips from Intel are called the 80186, 80188, and 80286. Not only do these chips execute these complex instructions much faster, but they have additional features.

The 80186 and 80188 (Intel's 100 series) are 16-bit and 8-bit cousins to the 8086 and 8088. Every 8088 and 8086 machine language instruction will also run on the 100 series chips, only much faster. Unlike the difficult process of moving programs from a Z-80 to an 8088, you can take a program that runs on an 8088 and move it without modifications to an 80188. The 80188 and 80186 also contain additional circuitry that replaces other portions of a microcomputer, including DMA circuitry, interrupt handling, and counters. The circuitry also adds a few new instructions. The net result is that you can create a personal computer using the 80188 that runs substantially faster than the 8088, and at a lower system cost.

The 80286 runs the same instructions as an 8088 and executes instructions at the same rate of speed as the 100 series chips, but it does not contain the additional computer circuitry. Instead, the 80286 has the capability of supporting virtual memory. To give you a feeling for how virtual memory works, consider this BASIC instruction:

`DEF SEG = 20000.`

On the 80286 a segment is not a real location in memory, but a pointer to 64K bytes somewhere. If the segment labeled 20000 is in memory, then DS will be loaded with the appropriate value and execution will continue. If the segment labeled 20000 is

## VIRTUAL memory is an exciting feature.

not in memory, then a routine can be called to read the appropriate 64K bytes from a disk, while writing out (that is, swapping with) a piece of memory that is not being used at the moment.

Virtual memory is an exciting feature. If you have only 128K of memory in your machine, you can still run a program that expects you to have 1000K. The program will not even know the difference, although you would notice more disk activity (for swapping segments in and out of the disk) than would someone who had the full complement of memory available.

In summary, the newer Intel chips serve two purposes. The 80186 and 80188 are designed to let manufacturers produce high performance, but inexpensive, personal computers. The 80286 is designed for high-performance virtual memory, usually on multi-user machines. All three chips run a superset of the 8088 instructions.

There are two good references for more information on these chips. The April 1983 issue of *Byte* has an excellent article describing the capabilities of the 80286 ("Virtual Memory for Microcomputers" by Stephen Schmitt) and an article describing the 80186 ("Intel's 80186" by Tony Zingale of Intel). Tracy Kidder, in his book *Soul of a New Machine* describes the internals of microprocessor chips in a readable manner.

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attempted to copy WordStar over to RAM-disk, via typing:

COPY WS \*.\* C:

I received the error message "file can not be copied to itself." What is going wrong?

Patrick M. MacLeod  
Kingston, Ontario, Canada

A: I am afraid that your problem is unrelated to the RAM-disk. Instead, the difficulty lies in a fine point in the printed instructions. (This sort of problem often happens when one attempts to copy a program from a magazine.)

The problem is that you left a space between WS and the first asterisk. The correct syntax should be:

COPY WS\*.\* C:

When you leave the space between the WS and the asterisk, PC-DOS takes your command to mean "COPY all of my files named WS to whatever their names are." Of course, this is illegal. It would be nice if PC-DOS announced that it had ignored the "C:," but it never reached that spot.

When you copy files using COPY, you are given the option of using ambiguous or unambiguous names (the documentation tends to call these "afn" and "ufn"). The simplest way to describe these two types is to first discuss naming conventions.

Every file in PC-DOS is described by a

**T**HE ASTERISK  
(\*) character matches  
any bunch of characters  
while the question mark  
(?) matches any single  
character.

prefix and a suffix. The prefix may be up to 8 characters in length and the suffix may be up to 3 characters in length. Valid names are WS.COM and CHKDSK.COM. The name CHECKDISK.COM is invalid because the prefix is 9 characters. These are unambiguous file names, because the name refers to exactly one file.

Sometimes it is easier to refer to a

bunch of files at once. PC-DOS uses special wildcard characters (\* and ?) to assist in that. Thus, when you call a file WS\*.COM, the name actually refers to any file whose prefix begins with the letters WS and whose suffix is COM. Similarly, WS\*.\* includes two wildcards; this name refers to any file whose prefix begins with WS and whose suffix can be anything.

A simple way to understand naming conventions is by experimenting with the DIR command. Place your PC-DOS diskette in drive A, type A:, press Return, and try entering the following:

DIR B\*.\*  
DIR BASIC.\*  
DIR BASI?.\*  
DIR \*B.\*  
DIR B?????.\*  
DIR B

After a few tries, you should be able to notice the following pattern in the results: The asterisk (\*) character matches any bunch of characters while the question mark (?) matches any single character. Note that \*B.\* will match any file, although you might expect it to require the prefix end with a B.

What you have done with the DIR command is testing how PC-DOS reacts to file names. DIR will list whichever files match the name you have selected. In PC-DOS, the space character is always a separator; this rule is different for the Apple computer, where a space can be used in file names.

The COPY command you tried to use acts like DIR, except that it takes two arguments. If the destination is a disk identifier like A:, then the argument is read as A:\*.\*. Some examples will help:

COPY A:\*.BAS B:\*.WIS—this will take every file on drive A whose suffix is BAS and copy it to drive B, while changing the suffix to WIS.

COPY A:\*. B:—this will copy every file from drive A to drive B (except files that are hidden, such as the PC-DOS system itself).

COPY A:WS\*.\* B:—this will copy every file on drive A whose prefix begins with WS over to drive B.

COPY WS\*.\* B:—this will copy every file on the default drive whose prefix begins with WS over to drive B. The default drive is the drive identified by the letter preceding the > sign when you are



in PC-DOS (that is, A> means A is the default drive).

COPY WS\*.CO? B:—this will copy every file whose prefix begins with WS and whose suffix begins with CO over to drive B. If B is the default drive you will get an error message.

## MANY PEOPLE wish to have their printers perform custom operations.

COPY WS.COM B:WS1—this will take the file named WS.COM on the default drive and copy it to drive B under the name WS1. If WS.COM is not found, a message to that effect will be displayed.

The process of naming and copying files is not a trivial one, and it is well worth learning. Certainly, it is easier to look at a short directory list generated by typing "DIR \*.BAS" rather than finding all the BASIC code files in the list produced by typing DIR \*.\*.

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I get an amazing quantity of letters each month asking how to perform various tricks with the WordStar text editor. This problem is particularly acute for people who don't have Epson printers, who will find that the cookbook approach given by various magazines is not informative.

I will describe how to make your printer, whatever it is, jump through hoops with WordStar.

Many people wish to have their printers perform custom operations. To do this, the first step is to look through the printer manual to find out which sequence of characters will cause that operation. As an example, I'll show how to do superscripting with the Epson FX-80. You turn superscripting on with this sequence: The ESCape character (number 27, or hex 1B) followed by "S0". You turn superscripting off by sending this sequence: ESCape "T". In BASIC, the instructions can be written as follows:

```
10 REM Turn superscripting on
20 LPRINT CHR$(27)+"S0";
```

```
30 REM Turn superscripts off
40 LPRINT CHR$(27)+"T";
```

If you know how to perform the operation within BASIC, you also can use WordStar to do the same thing.

WordStar provides you with four special purpose commands. They are Ctrl-Q, Ctrl-W, Ctrl-E, and Ctrl-R. To embed the control character within text you type Ctrl-P (hold down the Ctrl key and tap the P key), then key in the character (Q,W,E, or R).

When WordStar comes upon one of these control characters while printing, it sends a text string out to the printer (as LPRINT does in BASIC).

You define the string by putting it into the WS.COM file. In order to tell WordStar how long the string is, precede the string by a number showing its length.

Say I want to have WordStar send the string CHR\$(27)+"S0" whenever it sees a ^Q. The string has 3 characters, so inside of WS.COM I will need to first place the number 3 and then the string. The locations are (in hexadecimal):

Ctrl-Q =	077F
Ctrl-W =	0784
Ctrl-E =	0789
Ctrl-R =	078E

(I am assuming you use WordStar version 3.24 or version 3.3. These locations may differ for other versions of WordStar.)

Now, to change the WS.COM file, place the WordStar diskette in drive B and the PC-DOS diskette in drive A. Then respond to the prompts by keying in the underlined text:

(debug the file)

A>DEBUG B:WS.COM

(enter the right string)

-E77F 3 1B 'S0'

(write the new file back)

-W

(DEBUG will print a message here)

(now exit)

-Q

A>

Now, whenever WordStar sees a Ctrl-Q it will send 3 characters, Esc+"S0," to the printer. The E command tells DEBUG you wish to enter information. The letter E is followed by the hexadecimal address (here 77F tells where to put the information) and then by the actual data to be

placed (3 for the number of characters, 1B for the hex value of the ESCape character, and the other 2 characters are "S0"). The W command just tells DEBUG to write the file. The Q is a quit command.

Notice that with DEBUG you can enter arbitrarily complicated strings. If a number is entered not in quotes, DEBUG reads it as hexadecimal. Anything in quotes is read as a letter.

As another example, to set Ctrl-W as a key to turn off superscripting, we go through this sequence:

A>DEBUG B:WS.COM

-E784 2 1B 'T'

-W

-Q

A>

This string is only two characters, so in the second line precede it by the number 2. Escape is hexadecimal 1B, and Ctrl-W is found at location 784.

If you want to get custom reactions from a printer other than the Epson, just fill in the addresses with the string you wish sent, preceded by the length. Seems easy, doesn't it? Note that WordStar sets the maximum string length to 4 characters (5 counting the length byte), so the string can't be too complex.

If four strings are not enough, then you might wish to preempt the ribbon color changes (switched on and off by Ctrl-Y). These can be found at 0793 for Ctrl-Y on and 0798 for Ctrl-Y off.

For the FX-80 printer I use the on and off states of Ctrl-Y as an underline command. That way underlining can work with any font, including proportional spacing and enlarged text. If you wish to use enlarged text, you might prefer to preempt the alternate font characters. Alternate font is selected by Ctrl-A and deselected by Ctrl-N. The strings are found at 076B for Ctrl-A and 0770 for Ctrl-N.

If you use enlarged print, you should tell WordStar how large your letters are so it can justify correctly. The single value at address 037D is the size of each alternate character in 1/120-inch units (0C hexadecimal = 12 decimal = 12/120" = 10 pitch; 0A hexadecimal = 12 pitch).

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*Programming tips and insights into bugs are shared by members of the PC users community.*

# User-To-User

## Come a Little Bit Closer . . .

WordStar creates potential problems when you use it for writing programs or for preparing files that are to be transmitted via some telecommunications programs. When used in Document mode, WordStar sets the eighth bit of the last letter of every word to denote where it can justify and add "soft" spaces. In Nondocument mode, the eighth bit is never set. This "high" bit is not part of the ASCII character set and can cause a variety of strange occurrences when the file is used outside WordStar. The most obvious are the graphic and extended characters that appear when a WordStar file is TYPEd on the screen.

Here's a simple and useful technique for eliminating the high bit. In the back of your mind, keep the idea of using a file with a length of 1 character. It can be a lifesaver for some otherwise impossible programming tasks.

Reading "Letters to PC" in the June 1983 issue, I learned that some users have difficulty converting WordStar files into ASCII ones. I would like to suggest a simple BASIC program that will do the job (see Figure 1).

This program takes a byte from the input file, turns the eighth bit off, and writes it to the output file. The program can be further customized. For example, if you don't want to have WordStar control characters, type the following line:  
95 IF B<8 or (B<32 and B>13) goto 120

You can also print an output file while in BASIC. In order to do so, add this line to the program in Figure 1.

105 LPRINT B\$;

Boris Galinsky  
Brooklyn, New York

A problem with Galinsky's program is that it reads and writes one byte at a time. This is effective, but S-L-O-W. Here, in Figure 2, is an adaptation of his program that handles 128 bytes at a time. If you increase the buffer size to the string-handling maximum of 255 it will go faster still. The problem with the buffered program is that it becomes much more difficult to "filter" characters out of the file, so you can't add line 95 to my adaptation.

## Multikey Solution for Handicapped

Below is a very reasonable approach to the problems faced by users unable to press more than one key at a time. Occam's razor says that the simplest solution is the best one. Until someone comes along with a jazzy system for toggling keys like Ctrl and Alt (with 25th line status messages) I recommend Anthony Sebastian's approach.

I am suggesting a simple, effective, and reliable alternative method for toggling control keys (Shift, Ctrl, and Alt) on the PC keyboard for persons who have physical disabilities that preclude pressing more than one key at a time. (See letter to "PC Tutor" from Dal Vordahl, PC, Volume 2 Number 1, pages 74-75). Using plastic

Figure 1: A program by Boris Galinsky that converts WordStar files into ASCII.

```
10 LINE INPUT "Enter input file name: "; IN$
20 LINE INPUT "Enter output file name: "; OU$
30 OPEN IN$ AS #1 LEN=1
40 FIELD #1, 1 AS A$
50 OPEN OU$ AS #2, LEN=1
60 FIELD #2, 1 AS B$
70     GET #1
80     IF EOF(1) THEN GOTO 130
90     B=ASC(A$) AND 127)
100    LSET B$=CHR$(B)
110    PUT #2
120    GOTO 70
130 CLOSE
```



wrap, lead shot, and wire twist ties, fashion two weighted bags, each large enough to completely cover a PC key when placed directly on top of it. Position the shot bags on the keyboard just to the left of the vertical triad of control keys (Ctrl, Shift, Alt) in the valley between the control keys and the function key pad. The bags are "fluid," and it is relatively easy to "roll" one (or both) of them toward the right to depress, and keep depressed, one (or two) of the control keys. When you want to release the key (or keys), simply roll the weighted bag away. Thus, the control keys can be toggled.

I have been using this method of toggling the control keys on the PC keyboard for nearly a year and can attest to its effectiveness for a physically disabled person who would otherwise type one key at a time, using a rubber-tipped mouthstick. Two bags suffice, since I have not found any applications that require simultaneous sustained depression of a triad of control keys. A little experimentation to get the bags just the right size is necessary, and the range of bag sizes for effective toggling is considerable. The bags I use are large enough that as they rest in the valley between the function and control keys, they slightly overlap the left-hand edge of the control keys. Since they are fluid, it is easy to shift their center of gravity onto the control key. A few minutes experience is all it takes to learn how to use the bags effectively. It is not perceptively longer for me to toggle the control keys this way than

to toggle the CapsLock key.

Anthony Sebastian  
San Francisco, California

### Auto Formfeed after BASIC Listings

This technique will work with any printer that uses ASCII 12 (FF) as the standard formfeed. You can't put a regular formfeed into a BASIC program because it clears the screen and abandons the line on which you are typing. 140 sets the high bit of the formfeed character (128 plus 12), which tricks BASIC into taking no action on it. The high bit is stripped by PC-DOS when the character is sent to the printer, so the printer sees a true formfeed while you get a circumflexed i on your screen.

Doing a formfeed after LLISTing a BASIC program becomes a time-consuming task on the IBM printer because you have to follow all of these steps:

- Reach over to the printer and hit the on-line button.
- Hit the form feed button.
- And finally, when the printer has done its formfeed, the on-line button needs to be pressed again before printing.

Most of these can be done automatically by following these simple steps.

- Be sure the printer you have is an IBM (Epson MX/80).
- Load your BASIC program to be LLISTed.
- Then type in 65529 REM FORM FEED (don't hit enter yet).

- Type in Alt (and hold it down) while typing in 140 on the numeric keypad.
- Now hit Enter and LLIST away.

Brad Thurber  
Fort Wayne, Indiana

**D**ESPITE the problems with PC-DOS 2.0, it provides some wonderful features for hacking around, customizing, and personalizing.

### How Many Angels Can Dance on a Function Key?

Despite the growing list of problems with PC-DOS 2.0, it provides some wonderful features for hacking around, customizing, and personalizing. Here Ronald Parsons makes use of the two of them, ANSI.SYS and I/O redirection, to expand on the work done by Kenneth Wood in the June issue of PC.

The article, "Defining Function Keys with PC-DOS 2.0," mentioned that the Keyboard Key Reassignment (KKR) escape sequence had an undocumented limit of 128 bytes in its look-up table. The actual table limit is 190 bytes. The table, used to store the key redefinitions, contains a 1 byte length code followed by the string between the Esc [ and the p delimiters for each key redefinition. For example, the sequence Esc [0;68;"dir";13p would be stored as the hex string 07 00 44 64 69 72 13.

The Debug procedure given in Figure 3 creates a copy of ANSI.SYS with a larger look-up table. For ease in calculating the required numbers, I would recommend enlarging the table by a multiple of 80H bytes.

The expressions given in parentheses should be calculated and placed in the command without the parentheses. The length the table is extended is shown as xxxH. The numbers I used for enlarging my KKR look-up table by 200H bytes are shown near the right margin. My comments are in brackets.

Figure 2: An adaptation of Galinsky's program that handles 128 bytes at a time.

```

10 LINE INPUT "Enter input file name: "; IN$
20 LINE INPUT "Enter output file name: "; OU$
30 OPEN IN$ AS #1 LEN = 128
40 OPEN OU$ AS #2 LEN = 128
50 FIELD #1, 128 AS A$
60 FIELD #2, 128 AS C$
70   LSET A$ = STRING$(128, &H1A)
80   GET #1
90   FOR X = 1 TO 128
100      B$ = B$ + CHR$(ASC(MID$(A$, X)) AND 127)
110   NEXT
120   LSET C$ = B$
130   B$ = ""
140   PUT #2
150   IF EOF(1) THEN GOTO 200
160   GOTO 80
200 CLOSE

```



First make a copy of ANSI.SYS. Do not modify your original copy.

#### COPY ANSI.SYS ANSI.SYS

Then enter Debug, and issue the commands shown in Figure 3.

The entry in CONFIG.SYS should now be changed to DEVICE=ANSIX.SYS and the system rebooted.

A command file ANSI.CMD to be used as redirected input to Debug is shown below. The lines changing the CS and DS registers must, of course, be changed to match your system. My CS on entry to Debug was A8A and I made ANSI.SYS 200H bytes longer. Execute as: DEBUG ANSI.SYS < ANSI.CMD

```
r
r cs
a9a
r ds
a9a
r cx
880
a cs:12
dw 809

a cs:4ff
mov cx,809

a cs:530
cmp bx,2c8

f cs:680 87f 0
m cs:600 67f 800
f cs:600 67f 0
a cs:842
mov word ptr [bx+0e],809

a cs:84a
jmp 0de

r cs
a8a
r ds
a8a
w
q
```

This change will allow a much more reasonable KKR sequence to be defined.

Ronald G. Parsons  
Austin, Texas

#### Equal Time for EasyWriter

Just to prove that we actually pay heed to word processing packages other than WordStar, here is a simple procedure for getting EasyWriter 1.1 to turn underlining

on and off with an IBM Graphics Printer. Note that the general technique will work with any printer that provides enhanced print modes; just substitute the proper escape or control sequence.

I have the IBM Graphics Printer and have been trying to get EasyWriter 1.1 to use many of the capabilities of this unit, particularly for underlining words.

Here is a technique I now use and it works just fine. To send to the printer to "turn on" underlining mode is: Ctrl-O, then Esc, then hyphen(-), then 1. The

underlining mode will be in effect until you send a Ctrl-O, then Esc, then hyphen(-), then 0. While this works satisfactorily, it does take up three character positions each time you toggle the mode on or off. So, if you wish to underline only one word on a line, six additional characters must be added. This will create some alignment problems, even though the sequence does not affect the output.

I found a better way: defining .USERn commands. At the beginning of the document I set .USER1[ = Ctrl-O,Esc -,1 and

Figure 3: A Debug procedure by Ronald Parsons that creates a copy of ANSI.SYS with a larger look-up table.

DEBUG ANSI.SYS	{The program will be loaded at CS:100}	
R	{Determine current CS, DS and CX}	
R CS (old CS + 10H)	{Compensates for the load offset}	A9A
R DS (old CS + 10H)	{Compensates for the load offset}	A9A
R CX (old CX + xxxH)	{Sets file length to be written}	880
A CS:12 Dw (609H + xxxH)	{Fix pointer to initialization}	809
	{RETURN to end assembly}	
A CS:4FF MOV CX, (609H + xxxH)	{Pointer to initialization}	809
	{RETURN to end assembly}	
A CS:530 CMP BX, (0C8H + xxxH)	{Table length}	2C8
	{RETURN to end assembly}	
F CS:680 (67FH + xxxH) 0	{Fill extended table with zeros}	87F
M CS:600 67F (600H + xxxH)	{Move initialization code}	800
F CS:600 67F 0	{Zero old init code location}	
A CS:(642H + xxxH)	{Fix pointer to initialization}	842
MOV WORD PTR [BX + 0E], (609H + xxxH)		809
	{RETURN to end assembly}	
A CS:(64AH + xxxH)	{Fix jump to main code}	84A
JMP ODE		
	{RETURN to end assembly}	
RCS (CS: as it was on entry to debug)	{Restore original CS}	A8A
RDS (DS: as it was on entry to debug)	{Restore original DS}	A8A
W	{Write the new file}	
Q	{Quit debug}	



.USER2] = Ctrl-O, Esc -, 0, where "[" and "]" are unique symbols. All I have to do is use these symbols to designate the beginning and end of the text I wish to underline. This way only one character is needed to toggle the underlining mode. This is the exact sequence:

Type .USER1[  
Press and hold the Ctrl key  
Press the 0 key once  
Release the Ctrl key  
Press and hold the Esc key  
Press the hyphen(-) key once  
Release the Esc key  
Press the 1 key once  
Press Enter.

To "turn off" the underlining mode, follow the same procedure for assigning .USER2], but substitute 0 for the 1.

Raymond R. Hitney  
Putnam Valley, New York

### Loading Like Lightning

Irrepressible contributing editor Stephen Manes has a big tip for all of you

who use the BASIC interpreter often. BASIC's internal storage format takes up nearly 20 percent less space on disk, and can, as Manes points out, load several times faster. You should, as a matter of course, make a distinction between files

**WHEN  
BASIC loads an ASCII  
file, it has to spend  
time—lots of time—  
converting it to binary.**

stored in BASIC's internal format and those stored in ASCII. Use .BAS as the default for all internal format files and .ASC for those in ASCII format.

Got a favorite BASIC program that

takes 10 seconds short of forever to load from disk? Chances are it's been stored on the disk in ASCII format. When BASIC loads an ASCII file, it has to spend time—lots of time—converting it to binary.

You can check the file by entering TYPE FILENAME when in PC-DOS. If you can read the program listing, it's in ASCII.

The solution? Simply enter BASIC and load the program one last interminable time. Then save it in normal binary form, using the command SAVE "FILENAME." From then on, it should load like lightning.

Stephen Manes  
Bronx, New York

### Share Your Discoveries

Remember that "User-To-User" is your column. Send contributions to "User-To-User", PC Magazine, One Park Ave., New York, NY 10016. Please double-space all contributions, provide clean copies of program listings, and include the name of this department on your envelope.

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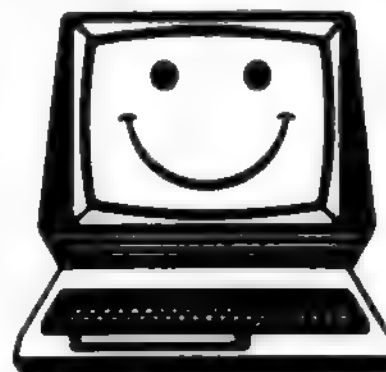
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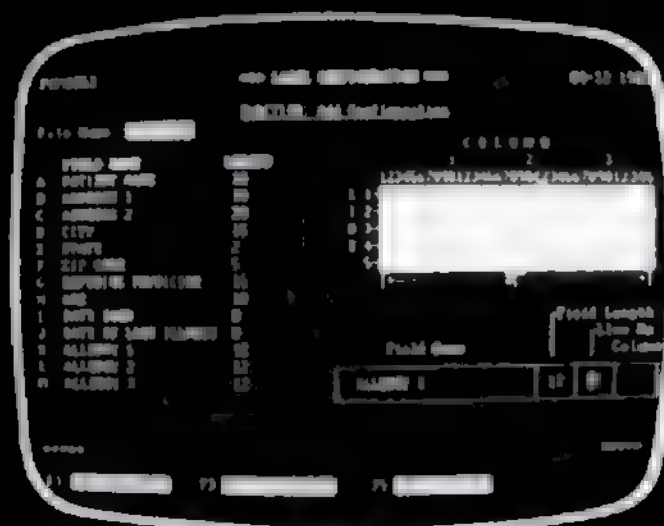
TOTAL RECALL - power and sophistication in list management for both the novice user (everything's in 'English') and the computer whiz (extremely flexible).

Simple to understand, fast to learn, and exceptionally easy to use.

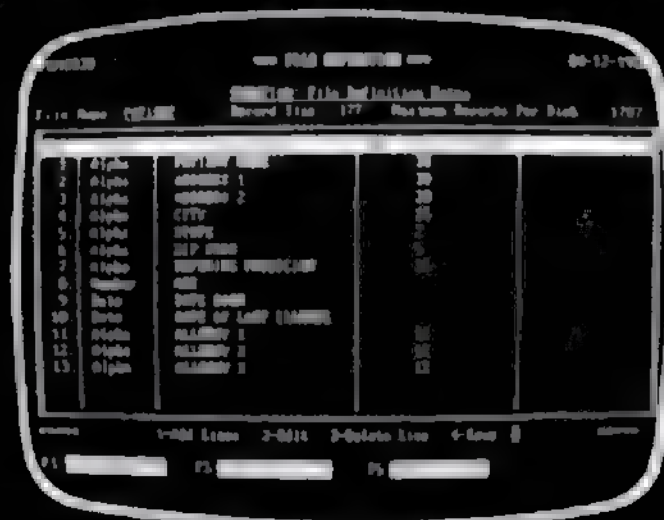
You can have this fast and highly efficient program running in less than one hour.

- For customer lists, patient lists, keeping track of prospects (last time called, number of children, etc.), organizing mailing lists to take advantage of Post Office discounts, and many other uses.
- Easy to Understand and Use - IBM® style manual filled with examples and complete 'English' language instructions.
- Complete 'For the Novice' Tutorial.
- Flexible Structure - with TOTAL RECALL you define your own entry format with up to 15 fields, 35 characters per field, plus numeric and date fields.
- Sophisticated List Management - You can extract entries from your list using up to 15 different parameters then sort your list up to 3 levels deep.
- Completely Menu Driven - no special codes to learn, no 'computerese' to wade through.
- Design your own Mailing Labels using your own data plus an optional message line. Prints 1, 2, 3, and 4 across labels.
- Especially easy to use with IBM Fixed Disk and other hard disks. All programs and data can be on the hard disk.
- Automatic totalling on numeric fields.
- Wordstar®, MailMerge®, PeachText®, and other word processors compatible for form letters and custom reports.
- Conversion facility for your existing files.
- DOS 1.1 and 2.0 compatible. Uses standard DOS files. Up to 100,000 records per file using DOS 2.0.
- IBM PC®, PC-XT®, Columbia®, Compaq®, and other popular MS DOS machines.

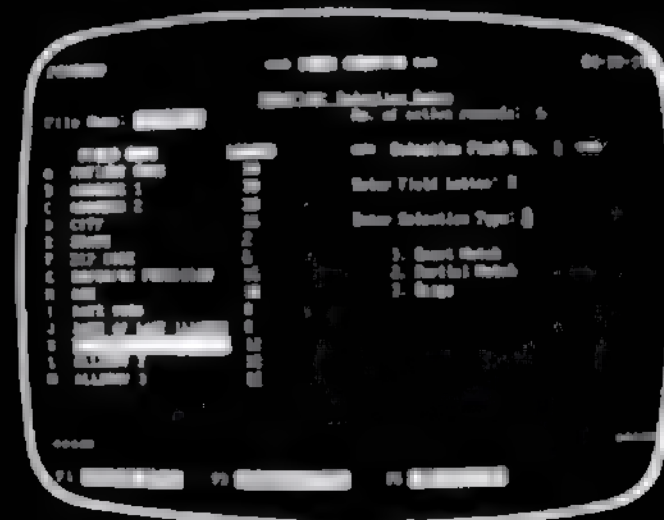
■ **\$129.95** Now at ComputerLand and other fine stores



**CUSTOM MAILING LABELS**



**FILE DEFINITION**



**FAST SELECTION/SORT**

## ANNOUNCING THE ADDITION OF NEW SOLUTION-ORIENTED SOFTWARE

Sophisticated application software for 16 and 32 bit microcomputers

### Packages For:

- Manufacturing Control (MRP)
- Property Management
- The Legal Profession

**SOFTA PUBLISHING**

A Division of The SOFTA Group, Inc. Formerly PCEZ Business Software

The SOFTA Group, Inc.  
778 Frontage Road Suite 106  
Northfield, IL 60093  
**312/446-SOFT**  
CIRCLE 360 ON READER SERVICE CARD



# New On The Market

## HARDWARE

### Keyboard Mouse

A mechanical mouse compatible without modification for use with any application program using cursor to make selections or entries.

The Keyboard Mouse includes an interface module which configures the device as a supplementary keyboard. The device is programmable from the user's keyboard, allowing the user to change the cursor and command controls on the unit. In addition, the handheld unit is equipped with three buttons that can be programmed to send special commands. Available as an option are five additional key switches for the device.

(List Price: \$295)

Product Associates, Inc.  
465 Convention Way  
Redwood City, CA 94063  
(415)364-3121

CIRCLE 768 ON READER  
SERVICE CARD

Keyboard Mouse,  
Product Associates, Inc.



### Busboard

A plug-in card featuring modular design, allowing the user to configure the card's functions through add-on function modules. Available function modules include: CP/M Plus Coprocessor Module, Async Communications I/O, 5 $\frac{1}{4}$ -inch Floppy Drive Controller, Parallel I/O Interface, Clock/Calendar, Game I/O, 16-Channel Analog Input A/D, 8-Bit I/O, and a blank Prototyping Module.

The Busboard offers 64K byte parity checking RAM on-board, expandable to 512K in 64K increments. Maximum expansion of 704K allows for emulation of a dual-sided disk drive, spooling of lengthy documents to RAM, and efficient use of the CP/M Plus Adapter Module's Z-80 co-processor. Included with the basic unit are BUSDRIVE, a disk drive emulator, and SPOOLBUS, a multi-printer, auto/manual queuing printer spooler. (List Price: \$349.95; Board without RAM and co-processor slot \$129.95)

LNW Computers  
2620 Walnut  
Tustin, CA 92680  
(714)544-5744

CIRCLE 775 ON READER  
SERVICE CARD



p1350 Printer, Toshiba America, Inc.

### Toshiba p1350 Printer

A dot matrix printer capable of near letter-quality printing at 100 characters per second, high speed drafts at 192 cps, and dot-addressable graphics at 180 x 180 dots per inch density. The printer features a 24-pin printhead design using fine wire 8-mil pins to create precisely placed overlapping dot matrices.

The 132-column printer can be equipped with standard friction roller or optional pin feed tractor or sheet feeder. Standard interface is Centronics-type parallel, with RS-232C serial hookup available as an optional configuration at no extra cost. (List Price: \$2,195)

Toshiba America, Inc.  
2441 Michelle Dr.  
Tustin, CA 92680  
(714)730-5000

CIRCLE 782 ON READER  
SERVICE CARD

### Prototyping Board

A circuit-design board with space for up to 72 16-pin inline chips, provided with power and ground grids and space for distributed power de-coupling. The card features gold flashed contacts on the edge connector and an area reserved for external interface connectors. The board is designed to be used with wirewrap sockets. (List Price: \$75)

Frontier Technologies Corp.  
P.O. Box 11238  
Milwaukee, WI 53211  
(414)964-8689

CIRCLE 784 ON READER  
SERVICE CARD



### PC 1024 Graphics Display

A display utilizing a 20-inch tube, capable of producing 1024 × 780 dot screens. The unit operates on a high video bandwidth, enabling the user to create a non-interlaced picture in high resolution without flicker. White phosphors, instead of green, allow the display to be viewed under a wide variety of lighting conditions.

Pictures are drawn on-screen at a rate of one million pixels a second. In alphanumeric mode, 128 characters by 50 lines can be displayed, and can be shown with graphics in mixed mode.

The unit incorporates an RS-232C interface, and can operate under PC-DOS, CP/M-86, and UCSD p-System. Its interface board contains a real time clock/calendar and bus extension cable.

(List Price: £4,300)

Riva Terminals Ltd.  
9 Woking Business Pk.  
Albert Dr.  
Woking, Surrey, U.K.  
(04862) 71001  
Telex: 85 9502

CIRCLE 777 ON READER  
SERVICE CARD

### Color Graphics Board

A plug-in board incorporating an Intel 8088 co-processor chip and a NEC 7220 VLSI graphics controller

chip to provide graphics with resolutions of up to 1024 by 1024, two planes of memory (4 colors available), RGB and composite video outputs, and a light pen interface in the minimal configuration.

Optional configurations allow the user to choose an additional third and/or fourth level of memory for up to 16 colors displayable simultaneously; a color look-up table option allowing the user to choose up to 16 colors from a palette of 4096; a mouse interface for graphics input; and an RS-232C port option allowing the on-board co-processor direct access to a plotter or digitizing tablet. (List Price: Basic board \$995; in optional configurations, up to \$1,995)

Frontier Technologies Corp.  
P.O. Box 11238  
Milwaukee, WI 53211  
(414)964-8689

CIRCLE 787 ON READER  
SERVICE CARD

### IBM 8087 Math Co-Processor

A specialized chip which, when installed on a user's system board, significantly increases the speed at which floating point arithmetic, logarithmic and trigonometric functions are processed. The option kit contains both the 8087 and a current level 8088 chip to ensure high performance of the co-processor is maintained be-

tween the two chips.

To take advantage of the 8087's capabilities, software designed specifically for the co-processor is required.

(List Price: \$260)

I.B.M. Corp.  
Systems Products Div.  
Entry Systems  
P.O. Box 1328  
Boca Raton, FL 33432  
(305)998-6007

CIRCLE 789 ON READER  
SERVICE CARD

## Submissions to "New On The Market"

Inclusion in "New on the Market" is at the exclusive discretion of the PC Editorial Staff.

PC Magazine cannot guarantee publication of a product announcement for a particular issue. In any case, submissions of material for "New on the Market" must be received no later than seven weeks in advance of the first week of the issue month. For example, for the August issue, all material must be in our hands no later than the middle of June, approximately 2 weeks before the ad closing date.

Submissions must include retail price, distribution methods, and details of required hardware and software. Include a phone contact for both marketing and technical questions.

The details for the product announcement should be submitted in typewritten form, double-spaced on one side of the paper. Whenever possible, include 8×10 glossy photograph of the product in black & white or color. If applicable, include screen photographs. For best quality, direct camera screen images are preferable to photographs from the monitor.

All material should be sent to: New on the Market, PC Magazine, 1 Park Ave., New York, NY 10016.

# New On The Market

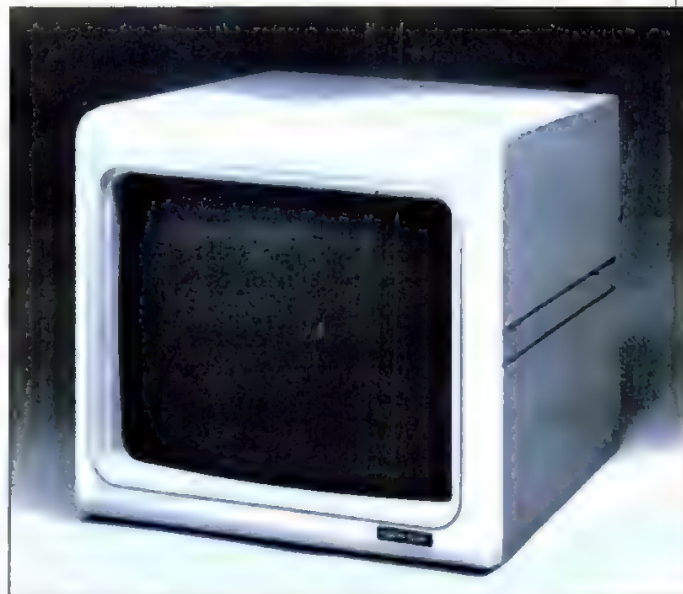
## Interfazer

A universal controller/buffer device capable of controlling the printing jobs of up to eight systems, on two printers. Interfazer can accept the printer output from one to eight computers through either serial or parallel I/O cards, and can store up to 128,000 characters in its buffer memory. Output to the printer can be parallel or serial, and baud rates from the computers need not match the rates into the printers.

The unit is based upon an 8085 microprocessor, and contains eight input slots and two outputs. It operates on a priority data basis (first data in, first out), and can also serve the user as an interface for incompatible equipment, computer I/O expander, data transfer rate converter, and additional peripheral buffer. (List Price: Base unit \$295; each additional 64K of memory \$295; parallel I/O or serial I/O cards \$65 each)

Quadram Corp.  
4357 Park Dr.  
Norcross, GA 30093  
(404)923-6666  
TWX: 810-766-4915

CIRCLE 780 ON READER  
SERVICE CARD



Quadscreen, Quadram Corp.

## Quadscreen

A display monitor measuring 17 inches diagonally, capable of displaying up to 10,240 characters onscreen at one time. Character configuration in text mode is either 120 characters by 64 lines using an eight-by-eight dot matrix, or 160 characters by 64 lines using a five-by-seven character matrix. Quadscreen also offers two full screens of memory of 64K each, and bit-mapped graphics resolution capability of 968 dots by 512 lines.

Additional features include reverse video and forward/backward scrolling. The controller board fills one expansion slot. (List Price: \$1,995)

Quadram Corp.  
4357 Park Dr.  
Norcross, GA 30093  
(404)923-6666  
TWX: 810-766-4915

CIRCLE 781 ON READER  
SERVICE CARD

## Quadcolor Boards

A plug-in board allowing bit-mapped high resolution graphics in up to 16 colors to be displayed. Two Quadcolor video boards are available. Quadcolor I is hardware and software compatible in text mode with the IBM Color/Graphics Adapter. Quadcolor II allows bit mapped resolution of 640 x 200 pixels in 16 colors.

Each Quadcolor board will drive most RGB or composite video monitors, and will support text. (List Price: Quadcolor I \$295; Quadcolor II \$275)

Quadram Corp.  
4357 Park Dr.  
Norcross, GA 30093  
(404)923-6666  
TWX: 810-766-4915

CIRCLE 774 ON READER  
SERVICE CARD

Interfazer, Quadram Corp.





### Printek 900 Series Printers

Three dot-matrix printers with automatic bi-directional printing, graphics capabilities, and an internal 1,800 character buffer. Model 910 offers speeds up to 200 characters per second in high speed mode, 22 software-controllable functions, eight character sizes, and seven foreign character sets in addition to its standard 96 ASCII character set. The 920 offers the same features, but with speeds up to 340 cps and two 8K buffers. Model 930 has a user-selectable dot density of 72 dots per inch in addition to the 144 dots per inch density available in graphics mode in all three models.

All units feature both RS-232C serial and Centronics-type parallel interface ports, baud rates from 300 bps to 9,600 bps, switchable parity settings, and can handle continuous forms, or cut sheets with optional feeders. (List Price: Model 910 \$1,595; model 920 \$2,395; model 930 \$1,995)

Printek, Inc.  
1517 Townline Rd.  
Benton Harbor, MI 49022  
(616)925-3200

CIRCLE 779 ON READER  
SERVICE CARD

### Advanced Communications Board

A communications board providing multiple protocol support capability (Sync, Async, HDLC, SDLC, CCITT-X.25), user-selectable DTE/DCE configurations, and switchable device addressing. Available options include a real time clock/calendar with battery back-up, and a parallel port.

In async mode, the board offers programmable baud rates from 110 through 19.2K, automatic error checking, programmable word lengths and stop bit lengths, and modem control

signal output. Sync mode features include automatic address field recognition, null, abort, CRC generation, CRC checking commands, as well as zero and sync-character insertions and deletions. (List Price: \$275, options \$40 each)  
Frontier Technologies Corp.  
P.O. Box 11238  
Milwaukee, WI 53211  
(414)964-8689

CIRCLE 796 ON READER  
SERVICE CARD

### IEEE-488 Controller

A board allowing up to 15 devices to be controlled through a standard IEEE-488 bus connector. The board performs controller, talker, and listener functions, and can link devices such as frequency generators, multimeters, speech synthesizers, power supplies, and other IEEE-compatible equipment to the user's system.

A real time clock/calendar with battery back-up, and an RS-232 port are available as options. (List Price: \$395; options \$40 each)

Frontier Technologies Corp.  
P.O. Box 11238  
Milwaukee, WI 53211  
(414)964-8689

CIRCLE 795 ON READER  
SERVICE CARD

900 Series Printers, Printek, Inc.



# New On The Market

## I-Bus Six Pac

An expansion chassis allowing up to six additional function boards to be added to a user's system. The chassis contains a 40-watt power supply and backplane with six slots. It is usable with virtually all PC-compatible boards, including RAM, floppy and hard disk interfaces, communications, and printer I/O boards.

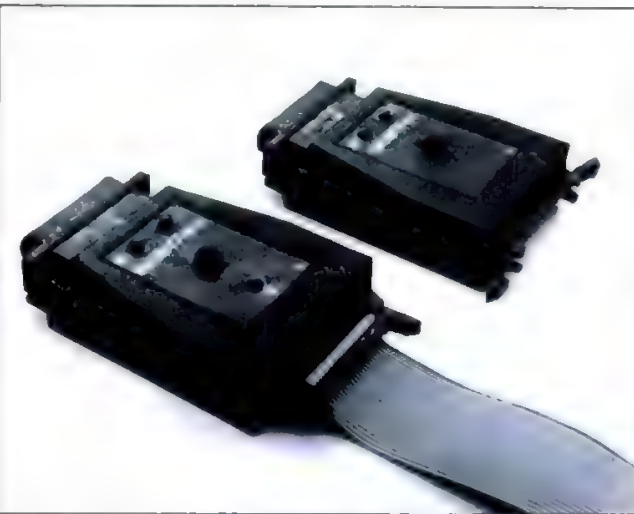
Connection to a user's system is by shielded interface cable, available in either an 18-inch or 48-inch length. An included interface card requires one slot in the user's system. (List Price: 18" cable \$695; 48" cable \$755)

**I-Bus Systems**

8863 Balboa Ave.  
San Diego, CA 92123  
(619)589-0646

**CIRCLE 778 ON READER SERVICE CARD**

Six Pac Expansion Chassis,  
I-Bus Systems



SC817 Smart Cable, IQ Technologies

## Model 358 Printer and Optional Sheet Feeder

A new addition to the Printstation 350 Series of printers, the Model 358 dot matrix printer provides bi-directional high speed draft printing, multi-pass correspondence quality printing, and four color or seven color print capability. Other features include a liquid crystal display providing printer status and feature selection, a 20-million character one-inch wide ribbon, and a rotary ribbon shifting mechanism designed to enhance color clarity and accuracy.

Other standard features include cut sheet and fan-fold paper handling abilities, both serial and parallel interfaces, pin-addressable graphics, self-diagnostics, and superscript/subscript printing.

Available as an option, the Automatic Sheet Feeder attachment uses paper/forms/envelope cassettes which allow the user to configure the feeder for one, two, or three bin operation. The unit automatically feeds sheets and envelopes in the proper sequence as controlled either by the user's system or through settings on the printer's control panel. (List Price: 358 Printer \$2,995; Sheet Feeder \$795) **Centronics Data Computer Corp.**

Hudson, NH 03051  
(603)883-6505  
Telex: 94 3404

**CIRCLE 769 ON READER SERVICE CARD**

## SC817 Smart Cable

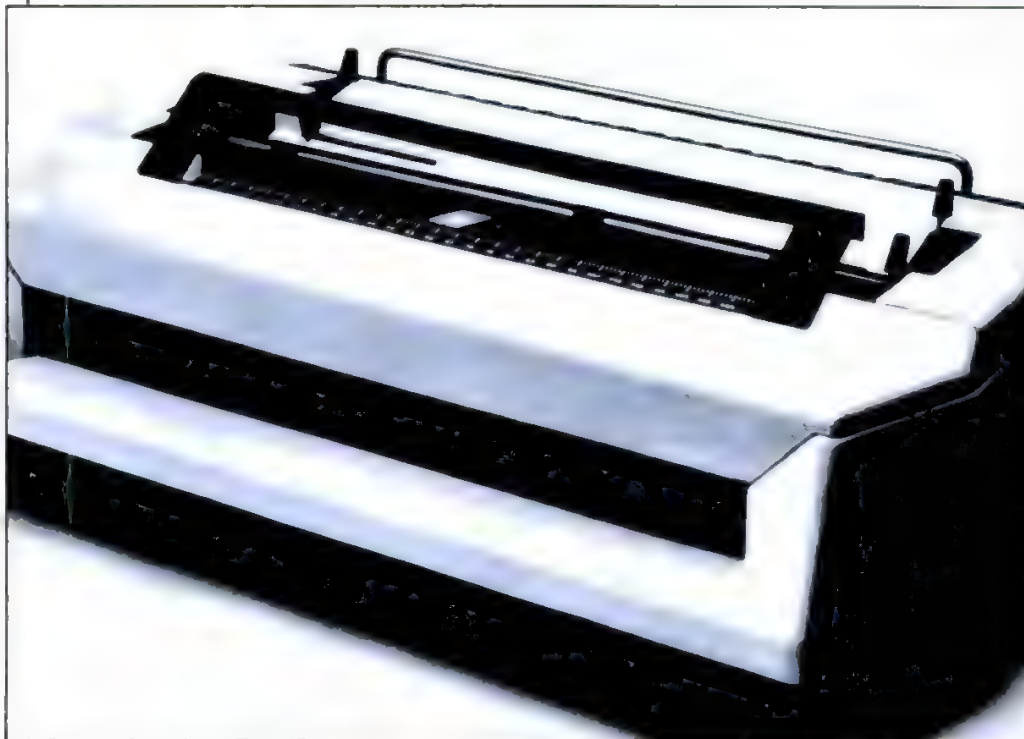
An RS-232 interface cable incorporating logic circuitry. The cable eliminates the need for custom cables to link peripherals to a user's system, as its circuitry is capable of connecting all handshake lines used in a specific application. The SC817 Smart Cable can function at baud rates up to 19,200.

The three state logic circuitry includes a "test" circuit, which characterizes the interfaces to which the cable is connected. In the event a connected device is hampering operations, an indicator light points out which device is at fault. A "pattern comparator" circuit determines the correct interconnect pattern required for the application, and activates the appropriate interconnect circuits to complete the connection.

The cable's three states of operation include positive voltage, negative voltage when driven by output circuits, or tendency to zero volts when driven by input circuits. (List Price: \$62.95) **IQ Technologies, Inc.**  
11811 N.E. First St. #308  
Bellevue, WA 98005  
(206)451-0232  
Telex: 70 1472

**CIRCLE 771 ON READER SERVICE CARD**





M45 Printer, Daisy Systems

### Daisy Systems M45 Printer

A daisywheel printer featuring as options both an RS-232 interface module and a switch-selectable interface module for RS-232, Current Loop, Centronics, and Data Products connections. The printer can run with different types of systems by switching the interface module's settings.

Other features of the printer include proprietary print hammer with seven printing intensities, and a separate motor drive for the ribbon cartridge that lessens

the need for frequent ribbon replacement. (List Price: \$1,995)  
Daisy Systems  
P.O. Box 1010  
Torrance, CA 90505  
(800) 4A-DAISY  
(800)441-5273 in Calif.

**CIRCLE 788 ON READER SERVICE CARD**

### Easiboard

A plug-in board incorporating 11 functions. The multifunction board contains Easisort, allowing sorting of data; Easispool, a printer buffer/spooler; three Easidisk electronic disk drive emulators that operate at faster processing rates than normal disk drives; Easitime and Easidate, providing clock and calendar func-

tions respectively; Easiswap, allowing the user to switch between two printers linked to the same system; a parallel printer interface; a communications port for modems or additional printers; and memory expansion of 64K or 256K RAM.

A software package, Easimaster, is included with the Easiboard. (List Price: Basic model \$325)  
Easitech Corp.  
2215 Perimeter Pk., # 22  
Atlanta, GA 30341  
(404)452-7576

**CIRCLE 770 ON READER SERVICE CARD**

### Monte Carlo GT and Quatro Boards

Two multifunction boards offering 64K to 1M byte of RAM, a clock/calendar with 13-year back-up battery, an RS-232 port, and a Centronics-type parallel port. In addition, the GT board offers adapters for use with two joysticks.

Both boards offer disk drive-emulating software, as well as on-board diagnostics capabilities. (List Price: Quatro \$375; GT \$425; additional RAM available at approximately \$60 per added 64K)

Micro Business Industries Corp.

1019 Eighth St.  
Golden, CO 80401  
(303)279-8438  
TWX: 910-934-0191

**CIRCLE 783 ON READER SERVICE CARD**

Monte Carlo GT Board, MBI Corp.



# New On The Market

## MULTIBUS Adapter

An adapter to link the user's system with the IEEE 796 standard MULTIBUS. The device consists of two cards. One fits a slot in the user's system, the other fits into a MULTIBUS card cage. The two cards are interconnected with flat cable.

Address mapping is provided to directly address up to 256K bytes of MULTIBUS memory. The user can establish the resulting target address in MULTIBUS address space by DIP switches. Another set of switches selects the range of MULTIBUS I/O addresses that can be accessed by the user's system.

The MULTIBUS Adapter contains 8K bytes of static RAM, which can be mapped into any unused address space in either the user's system or MULTIBUS. The RAM is a dual port concurrent access memory, and both the user's system and MULTIBUS can access the RAM simultaneously. The 8K static RAM provides memory or a DMA buffer for MULTIBUS use. (List Price: \$995)

Bit 3 Computer Corp.  
8120 Penn Ave. So.  
Minneapolis, MN 55431  
(612)881-6955

CIRCLE 776 ON READER  
SERVICE CARD

## MasterGraphics Adapter

A single card that replaces three IBM graphics adapters—Monochrome Display and Parallel Printer, Color/Graphics Monitor, and Parallel Printer. MasterGraphics functions include a palette of 4,096 colors, MasterSet software and hardware to allow users to create their own character generators, and a Dual Display kit for simultaneously linking an RGB monitor and an IBM Monochrome display to the same system.

The MasterGraphics Adapter I provides four times the storage capacity of IBM adapters, increases active colors from four to 16, and can provide resolutions of 640 × 200 in 16 colors and 780 × 340 in high-res monochrome. (List Price: \$579)

Micrographics Technology Corp.  
1820 McCarthy Blvd.  
Milpitas, CA 95035  
(408)996-8423

CIRCLE 791 ON READER  
SERVICE CARD



Messenger Interface Module, Smith Corona

## Portable Typewriter/Printer and Interface Module

A portable typewriter that can also serve as a letter-quality computer printer when linked to a user's system through a Messenger Typewriter Interface Module. As a typewriter, the Memory Correct III Messenger features full-line correction, with automatic relocation to original position after correction; multiple pitch for 10, 12, or 15 characters per inch spacing; and reverse tab to facilitate statistical typing.

With the Messenger Interface Module, the unit is converted into a computer printer with the same features as in its typewriter mode, including automatic centering and underlining. The Module is provided with both serial and Centronics parallel outlets.

Available options for the typewriter/printer include ten daisywheel type styles. (List Price: Typewriter \$599; Interface Module \$170) Smith Corona, Inc.  
65 Locust Ave.  
New Canaan, CT 06840  
(203)972-1471

CIRCLE 772 ON READER  
SERVICE CARD



## SOFTWARE

### PC Calculator and Programmable PC Calculator

Two programs which act as 16-digit calculators, with all key function definitions visible on-screen. Various display options included with the program, as well as printout formats, are selectable by the user. The numbers in 26 working registers are visible on the screen during calculations.

Programmable PC Calculator can create and access over 250 calculation programs, each up to 102 steps in length. During programming and editing, all program steps are on display, and editing allows step by step deletion or insertion. During a program run, a routing indicator follows the progress of the calculation through the program's steps.

In addition, a package of widely-used financial functions is available as an option for the Programmable PC Calculator program. (List Price: PC Calculator \$29.95; Programmable PC Calculator \$49.95; latter with Financial package \$59.95) **Requires:** 64K, one disk drive, 80-column display. CTEK Corp.  
748 E. Colorado Blvd.  
Pasadena, CA 91101  
(213)795-7877

CIRCLE 707 ON READER  
SERVICE CARD

### Micro-FRS

An asset/liability management program and Financial Results Simulator for banks and savings and loan associations with assets up to \$5 billion. Features include a Target Balance approach whereby the user enters balance sheet goals and the program computes new volumes necessary to meet the goals; a rate generator facility; Gap Analysis Reports provided on both a static and dynamic basis for current and future periods; and the facilities to print out Call Reports Schedules J. (List Price: License and on-going use fees range \$3,500 to \$11,500)

**Requires:** 128K, two 320K disk drives, MS-DOS, or CP/M-86, 132-column printer. Sendero Corporation  
4815 North Fourteenth Pl.  
Phoenix, AZ 85014  
(602) 279-0401

CIRCLE 699 ON READER  
SERVICE CARD

### System Manager Vers. 1.0 & 2.0

A program providing users with a menu of DOS commands, with which the user can access any of up to 12 applications programs with a single keystroke. The program can run any .COM file (WordStar, dBASE II, etc.) or BASIC file. Resident utilities return control to main menu automatically after an application program has run. In addition, the System Manager provides password security, one level in the PC-DOS 1.0 version, and three levels (down to DOS security) on the 2.0 version.

The PC-XT version of System Manager allows up to 20 applications programs to be selected from a user-definable menu, and makes use of tree-structured directories, allowing the operator to create and access subdirectories on a hard disk. In addition, the PC-XT version provides function key macros, "point and do" cursor control commands, as well as basic utilities. (List Price: Both versions \$89 each) **Requires:** Version 1.0: 64K, two disk drives, PC-DOS 1.0; PC-XT Version: 128K, Hard Disk, PC-DOS 2.0. Business Management Systems, Inc.  
9526-A Lee Hwy.  
Fairfax, VA 22031  
(703)591-0911

CIRCLE 711 ON READER  
SERVICE CARD

### FTP

A file transfer utility allowing files to be transferred to or from a mainframe system. The program consists of two parts, one for a mainframe system operating under TSO or VM/CMS, and a part for a user's system running PC-DOS or CP/M.

FTP contains a layered protocol, including full Cyclic Redundancy Checking and automatic entry to ensure data integrity at high line speeds. Its micro component contains an asynchronous terminal emulator, which allows the user to dial the mainframe system, connect to TSO or VM/CMS, and issue either an Upload or Download command.

The utility program is supplied on magnetic tape and on appropriate disks. (List Price: \$4,000, including up to 10 copies of the micro version; additional micros at \$50 each) **Requires:** 64K, one disk drive, PC-DOS, monitor, serial interface, modem. On-Line Business Systems, Inc.  
115 Sansome St.  
San Francisco, CA 94104  
(415)391-9555

CIRCLE 706 ON READER  
SERVICE CARD

# New On The Market

## PROJECT SCHEDULER and BAR GRAPH GENERATOR

Two utility programs to display data or graphs without requiring a color/graphics adapter board in the user's system. **DATA SCHEDULER** allows projects to be displayed, showing up to seven different tasks (sub-projects) at one time. Data is displayed on a day-by-day basis and shows the length of each task to be performed; whether it is firm or a proposed task; and who has responsibility for the completion of each specific task. Projects can be as long as two years, and up to 10 weeks of data can be displayed at one time.

**BAR GRAPH GENERATOR** allows the creation of bar graphs to display statistical information without programming. The user is presented with a fill-in-the-blank screen and is asked to describe the graph and enter data. Screen displays one to three graphs simultaneously, in a choice of three formats with up to 15 time periods represented. (List Price: \$35 each)

**Requires:** 64K, one disk drive, monochrome monitor.  
**DATA\*EASY Software**  
877 Bounty Dr., # EE203  
Foster City, CA 94404  
(415)571-8100  
(415)349-4001

CIRCLE 712 ON READER SERVICE CARD

## MergeCalc, LoadCalc, and DocuCalc

Three enhanced function programs for use with VisiCalc or 1-2-3 spreadsheet programs. **MergeCalc** allows the user of a spreadsheet program to consolidate, merge, and manipulate different models without affecting the integrity of the data within each model. The program allows addition, subtraction, multiplication, or division of up to 15 models at one time, on files in /SS, DIF, or WKS formats.

**LoadCalc** can read simple text files and convert them into a form necessary for manipulation by, or incorporation into VisiCalc or 1-2-3 models. Text files can be captured with communications programs such as VisiTerm or R/Net, then loaded into the spreadsheet program directly, without special reformatting or programming. Fractions, such as those that appear on Dow-Jones data, are interpreted and converted automatically into decimals.

**DocuCalc** can print any section or all of a user's spreadsheet model in seven formats. It can show a model's equations, labels, and values in a grid layout, preserving orientation. One grid format wraps long equations so that they remain in their correct positions and are not truncated. Another moves long equations to the end of a report, and a third shows just a single reference letter for each column (E for equation, L for label, etc.) and shows columns A through BK on a single page. Single cell per line reports can be by row or column, with attributes in English (e.g. Two Decimal instead of /F\$). **DocuCalc** can also detect and report any forward or circular reference which may cause erroneous results in a model. (List Price: **MergeCalc** \$125; **LoadCalc & DocuCalc** \$95 each)  
**Requires:** 96K (**MergeCalc**: 128K), one disk drive, PC-DOS, Visicalc or 1-2-3.  
**Micro Decision Systems**  
P.O. Box 1392  
Pittsburgh, PA 15219  
(412)276-2387

CIRCLE 713 ON READER SERVICE CARD

## STATGRAPHICS.PC

An interactive data analysis and statistical graphics program, containing over 200 numerical and graphics functions. The program consists of 30 workspaces, including a core workspace containing basic system functions used by most procedures. Individual statistical procedures are then copied into the active workspace from one of 26 available through the program's main menu.

The program includes a general interface to control attached pen plotters, configured for the I.B.M. XY/750 but adaptable to other plotters. For systems with both monochrome and color/graphics monitors, the program allows the user to separate text and graphics output. All input and text output is produced on the monochrome monitor, while all graphics output is displayed on the other. (List Price: **First User's License** \$475; additional licenses \$80 each)

**Requires:** 192K, one disk drive, PC-DOS, color monitor, color/graphics adapter, serial adapter board.  
**Statistical Graphics Corp.**  
P.O. Box 1558  
Princeton, NJ 08540  
(609)924-9374

CIRCLE 715 ON READER SERVICE CARD





Total Materials & Total Inventory. TCS Software

### TCS TOTAL MATERIALS & TOTAL INVENTORY Programs

Materials/parts tracking and inventory control programs for manufacturing plants, intended to be used together as a system. The programs allow the user to determine quantities of parts in stock, the number of finished goods that can be produced with the parts currently on hand, and can generate several types of bills of materials and production reports. In addition, the programs will automatically update inventory items as parts are used or replaced.

Current inventory levels can be maintained on an item-by-item basis for all raw materials, work in progress, and finished goods. The two programs used together include reports on productivity, material requirements planning, new product development and engineering changes, and production cost analyses and reconciliations.

**TOTAL MATERIALS** also provides such information as reference numbers for engineering drawings and parts list numbers, next higher assembly, user comments, and page references to relate multiple assemblies to the finished product. (List Price: \$500-\$1,200 for each program, depending upon dealer support)

**Requires:** 64K, one disk drive, PC-DOS.  
TCS Software, Inc.  
3209 Fondren  
Houston, TX 77063  
(713)977-7804

CIRCLE 730 ON READER SERVICE CARD

### PeachFix and Stock Price Catalog

Designed to be used with I.B.M./Peachtree Accounting software, **PeachFix** allows the user to place version 1.0 programs on a single 320K disk, eliminating the need to change disks each time a new menu is required. In addition, **PeachFix** can obtain such information as date and time automatically from the system's DOS, precluding manual entry of such information each time an application is run.

**Stock Price Catalog**, intended for use with I.B.M./Peachtree's **Accounts Receivable** program, version 1.0, maintains a perpetual inventory of items in stock. It allows the user to automatically track quantities of materials on hand prior to invoicing, generate out-of-stock and stock reorder reports, and monthly profitability reports for each item in stock. The program can support an inventory of up to 3,100 separate items identified by a 1-to-15 character I.D. number. (List Price: **PeachFix** \$24.95; **Stock Price Catalog** \$495)

**Requires:** 64K, two 320K disk drives, PC-DOS 1.1, I.B.M./Peachtree software, version 1.0.  
**Micro-Comp Business Enterprise, Inc.**  
5021 Kurt Ln.  
Conyers, GA 30208  
(404)922-6319

CIRCLE 728 ON READER SERVICE CARD

### Peerless AgriSystems Programs

A series of programs designed for farmers and agribusinesses. The programs include **Crop and Field Management**, **Livestock Management**, and **Grain Elevator Management**, among others. The programs are integrated with each other, and with the **Peerless Accounting and Management Analysis System**, a financial management system which allows for both book value and fair market value accounting simultaneously, as well as unlimited Enterprise Accounting with TEFRA and GAAP compliance.

Future releases within the **AgriSystems** series will include programs for specific farming applications and farm types, soil types and fertilizer formulations, regional variances and crops. (List Price: \$500- \$1,800, depending on module)

**Requires:** 128K, two disk drives, PC-DOS.  
**Peerless AgriSystems Software Div.**  
Box 10339  
San Antonio, TX 78210  
(512)533-1274

CIRCLE 710 ON READER SERVICE CARD



# New On The Market

## PolyLibrarian

A software development tool for programming using the PC-DOS (MS-DOS) operating system. PolyLibrarian organizes related object code modules (.OBJ files) into a single library (.LIB file). The IBM PC Linker can then automatically select only the modules needed to construct an executable program.

PolyLibrarian works with any compiler or assembler that uses the IBM PC Linker. Programmers can reduce code size, simplify structured programming, construct libraries, or examine and reorganize existing libraries. (List Price: \$99) Requires: 64K, one disk drive, PC-DOS.

Polytron Corp.

P.O. Box 787

DS 2-203

Hillsboro, OR 97123

(503)640-2875

CIRCLE 726 ON READER  
SERVICE CARD

Super\*List Manager,  
Pinnacle Software



## SUPER\*LIST MANAGER

A database management program incorporating sort/select functions and a word processing system. The program's structure utilizes predefined formats, record layout, and item definitions. SUPER\*LIST MANAGER allows the user to print display screens with a single keystroke. Its sort/select function selects through up to 2,400 records using any database item on file, with up to four levels of selection criteria.

The word processing functions allow the user to compose and store up to 15 formatted reports, to combine form letters with names and addresses stored in the database component, and to edit existing letters or create new ones. SUPER\*LIST MANAGER can be used for such applications as warranty records, subscriber lists, real estate listings, personalized records, word processing, and direct mail. (List Price: \$249)

Requires: 64K, two 320K drives, PC-DOS 1.1, monitor, printer.

Pinnacle Software Systems  
P.O. Box 1220  
Ft. Collins, CO 80522  
(303)224-5061

CIRCLE 721 ON READER  
SERVICE CARD

## MUSE

A word processing program capable of printing out documents exactly as they appear on a user's display. MUSE features include a spelling checker; a mailing list processing capability; an abbreviation glossary; column move, copy and erase; decimal tabs; hyphenation; copying and moving of portions of documents; and a high speed cursor movement control system.

More advanced features include cursor-controlled document selection and deletion, a document recovery facility, and document encryption. MUSE also offers the user the flexibility of converting MUSE files to DOS files, of customizing menus and dictionaries, and of accessing MUSE in several different languages. (List Price: \$595)

Requires: 256K, two 320K drives, PC-DOS 1.1 or 2.0, monitor.

MARC Software International, Inc.

260 Sheridan Ave. #200

Palo Alto, CA 94306

(415)326-1971

TWX: 910-373-2013

CIRCLE 735 ON READER  
SERVICE CARD

## BasicWindow

A programming development tool that allows BASIC application programmers to generate customized screens for new programs. BasicWindow consists of a Screen Editor, for designing and entering custom screens; a Screen Driver, which the user includes in BASIC applications programs to perform BasicWindow operations; and a Macro Processor, which can translate the BasicWindow request statements in the user's application into actual BASIC statements.

To access and use a screen in an application, the user includes BasicWindow macro statements into his BASIC program, and compiles the program using the included BasicWindow Macro Compiler. The result is a copy of the user's program with all of the BasicWindow commands translated into standard BASIC language statements. (List Price: \$99.95)

Requires: 64K, one disk drive, PC-DOS, 80-column monitor, BASICA or BASIC Compiler.

G. Freeman & Co.  
Software Design Group  
15 Albin Rd.  
Stamford, CT 06902  
(203)327-9868

CIRCLE 752 ON READER  
SERVICE CARD



### Peeks 'n Pokes for the I.B.M. Personal Computer

A collection of 50 programs, eight utilities, and techniques for programmers to perform functions otherwise unavailable from BASIC or Pascal. The package includes a disk and 38-page manual, illustrating the use of BASIC PEEK, POKE, INP, and OUT functions to access and modify system information. Also included are general-purpose assembler subroutines used to perform DOS and BIOS function calls, read the file directory, and determine the amount of space on a disk that has been used and that is still available.

For the Pascal programmer, assembler subroutines that perform the same functions as those listed above are included. Sample programs demonstrate the use of these functions and the use of the DOS/BIOS sub-routine.

Eight utilities are included on the disk to perform such functions as clearing the screen, swapping monitors, and displaying date and time. (List Price: \$30) **Requires:** 64K, one disk drive, PC-DOS, 80-column monitor.

*Data Base Decisions*  
14 Bonnie Ln.  
Atlanta, GA 30328  
(404)256-3860

CIRCLE 717 ON READER  
SERVICE CARD



Peeks n' Pokes, Data Base Decisions

### UltraTRAP

A parity error handling utility program designed to reset the parity error detection circuitry and report the condition to the user via the monitor instead of halting the machine.

*UltraBOOT*, a dynamic memory allocation utility, and *UltraFAST*, a flexible disk RAM emulator, are also included. (List Price: \$39.95) **Requires:** 64K, one disk drive, PC-DOS 1.1. Daystar Systems, Inc. 10511 Church Rd., #L Dallas, TX 75238 (214) 341-8136

CIRCLE 720 ON READER  
SERVICE CARD

### Entrepreneur Software Series

A series of six software packages, consisting of *VisiCalc* templates and files in DIF format. Designed for use in starting up new small to medium-sized businesses, the programs are keyed to 200 business books, covering specific industry information for a range of small businesses.

**Package ONE**, for 30 "business service" businesses, covers consulting firms, print shops, publishing, video production, employment and travel agencies, advertising, seminar organizing, among others. **Package TWO** works with 30 books aimed at "consumer service" fields, such as day care centers, car rental agencies, coin laundries, automotive services, and similar services.

**Package THREE**, used with 24 books, covers the food and beverage industry. **FOUR** deals with 20 businesses with unique facilities requirements, such as physical fitness centers, video arcades, and dance studios.

**Package FIVE** is aimed at retail merchandizing, and examines the operations of more than 50 different businesses. *SDX* is designed for use by those interested in up to 50 low start-up cost businesses, such as mail order, street vending, craft sales, and the like. (List Price: \$75-\$95, depending on package) **Requires:** 64K, one disk drive, *VisiCalc*. Entrepreneur Magazine 3211 Pontius Ave. Los Angeles, CA 90064 (213)478-0437

CIRCLE 722 ON READER  
SERVICE CARD

# New On The Market

## L.I.F.E. Goals

A financial investments analysis program allowing professional investments advisors to produce a detailed, custom Financial Plan for each of their clients. Plans produced by the program run 18 to 26 pages, and consist of explanation and analysis of the client's present and proposed financial situations.

Analyses generated include a financial statement, monthly budgeting profile, investment performance, college funding needs, effects of inflation, life insurance needs, retirement capital needs, asset diversification, individual retirement accounts, five year tax planning, and home refinancing. Federal income tax and Social Security retirement and survivor benefits are automatically computed. (List Price: \$945)

**Requires:** 64K, two disk drives, CP/M or MS-DOS, SuperCalc, WordStar, Mail-Merge programs.

**Kinnaird SoftPlans**  
2953 N.E. Brogden St.  
Hillsboro, OR 97123  
(503)640-2875

CIRCLE 737 ON READER  
SERVICE CARD

## The Work Management System

A program designed to assist field operations managers in work scheduling, evaluations, and productivity, to help justify capital expenditures, allocate resources, and develop work plans. The Work Management System is intended primarily for use by municipalities, and can provide data in both work backlog and work performed for such areas as streets, sanitation, parks, buildings, utilities, airports, and traffic control. It can be adapted for use in plant and facilities maintenance, grounds maintenance, and construction work. (List Price: \$3,950, including perpetual license, technical installation, and six months software maintenance)

**Requires:** 128K, 2MB Hard Disk, PC-DOS, dBASE II.  
**LFWF Group**  
12700 Park Central, #1805  
Dallas, TX 75251  
(214)233-5561

CIRCLE 755 ON READER  
SERVICE CARD



Decision-Analyst, Executive Software

## Decision-Analyst

A program providing businessmen with the ability to analyze complex problems where there are many alternatives and/or criteria to be examined and evaluated.

The program takes the user through eight menu-selected sections including problem definition, statement of decision purpose, establishing and weighing of "want" and "must" criteria, calculation of critical values, defining alternatives, weighting and scoring alternatives against criteria, assessing possible adverse consequences, and final conclusions and choice.

(List Price: \$139)

**Requires:** 96K, one disk drive, CP/M-86 or PC-DOS, 80-column monitor, 80-column printer.

**Executive Software, Inc.**  
Two N. State St.  
Dover, DE 19901  
(705)722-3373

CIRCLE 725 ON READER  
SERVICE CARD

## 4CaST/1

A business forecasting program incorporating eight different techniques, with the capability of displaying forecasts in color graphics.

Transform utilities allow the user to develop custom forecasting techniques to add to those pre-programmed.

4CaST/1 can be linked to spreadsheet programs such as VisiCalc, and can accept data downloaded from mainframe systems. (List Price: \$725)

**Requires:** 128K, one disk drive, PC-DOS, color/graphics adapter, monitor.  
**HEURIX Computer Products**  
P.O. Box 9227  
Morristown, NJ 07960  
(201)267-2806

CIRCLE 740 ON READER  
SERVICE CARD



### **PEAR Technical Analysis**

An investment analysis program that can help a user identify profitable strategies for trading and investment. The program is divided into subcomponents that provide graphics, modeling, evaluation, and data retrieval.

With PEAR Technical Analysis, the user can create decision rule models, evaluate the performance of models over any time period, and analyze price data using a range of graphics generating capabilities.

Automatic pricing data can be obtained through DIAL/DATA, which gives users access to the Merlin database of daily and historical price information for securities, commodities, stocks, options, bonds, government issues, mutual funds, and financial futures. (List Price: \$1,450; DIAL/DATA prices variable, depending on data requested) **Requires:** 128K, two disk drives, PC-DOS or p-System, Hayes Smartmodem. Remote Computing Corp. 1076 E. Meadow Cir. Palo Alto, CA 94303 (415)494-6111

**CIRCLE 753 ON READER SERVICE CARD**

### **Personal Computer Data Interface (PCDI)**

An integrated telecommunications, database management, and graphical analysis program. PCDI is configured to communicate with IBM's VM/370 operating system, though it may be modified for other systems. The program can automatically retrieve data from a mainframe system at either 300 or 1200 baud, in either ASCII or EBCDIC/correspondence codes. Data compression techniques incorporated in the program effectively increase transfer rates between mainframe and the user's system.

The program's data management facility includes two-dimensional tables for time-series variables, referenced in common English. A full screen editor allows scrolling, global editing, and subsetting. PCDI automatically keeps track of the user's data files, and an export feature allows data files to be reformatted for entry into VisiCalc and other application programs.

The graphical analysis section of the program allows the user to create charts with text, and up to two charts may be displayed simultaneously. Pie charts and histograms can be scrolled to allow the viewing of up to 208 periods of data per variable, and alternate Y-axes are supported, allowing analysis between differently scaled variables. Data can be projected forward an additional twenty periods, using the least squares method.

Text and/or graphics can be printed at any time using an IBM or Epson printer. (List Price: Unlimited corporate license fee \$30,000; monthly rental \$800; Single user package \$250)

**Requires:** 256K, 5Mb hard disk, PC-DOS 1.1 or 2.0, color monitor, color/graphics adapter, Hayes Smartmodem.

Applied Microsystems, Inc.  
P.O. Box 832  
Roswell, GA 30077  
(404)475-0832  
(404)371-0832

**CIRCLE 754 ON READER SERVICE CARD**

### **Master Utilities Vol. #1**

Three utility programs allowing features upgrading of a user's system fitted with additional RAM boards. MASTERspooler I allows the user to assign any portion of the available memory to function as a printer spooler driving the serial port. The program will dump the data to be printed into the spooler RAM, freeing the rest of the user's system. MASTERspooler II is similar, but drives the parallel port.

MASTERdisc is a disc emulation program which can create a second or third disc using RAM. All three utilities may be used simultaneously, and each of the sections may be allocated as much RAM as required by the user, in 1K increments. The programs will show amount of available RAM still unused in the system. (List Price: \$49.95)

**Requires:** 64K, one disk drive, PC-DOS, additional RAM board. Microtek Inc. 4750 Viewridge Ave. San Diego, CA 92123 (619)569-0900 TWX: 910-335-1269

**CIRCLE 754 ON READER SERVICE CARD**

# New On The Market

## Maintenance

### Management System

An integrated maintenance management package that allows the user to maintain records and generate reports on plant equipment, inventory control, and work order processing. The package components consist of Machine History and Preventive Maintenance, with which the user can maintain detailed records on preventive maintenance schedules and work performed for each machine, as well as complete machine histories and repair work histories; Work Order System, which can keep track of labor, material, and total costs for each work order received; and Inventory Control, which stores and retrieves part numbers and other items in inventory, and which keeps track of quantities on hand, based on transactions. (List Price: \$795; manual alone \$25) **Requires:** 64K, two disk drives, monitor, printer. Unik Associates  
12545 W. Burleigh  
Brookfield, WI 53005  
(414)782-5030

CIRCLE 747 ON READER  
SERVICE CARD

## <<MEMORY/SHIFT>>

A program designed for the PC-XT, allowing the user to have up to 9 different application programs in system memory simultaneously. <<MEMORY/SHIFT>> also allows the simultaneous use of two monitors, each displaying a different program, and will allow data transfers between different application programs to take place with few keystrokes. (List Price: \$99)

**Requires:** IBM PC-XT; 128K, one disk drive, PC-DOS 1.1 or 2.0.

North American Business Systems, Inc.  
642 Office Pkwy.  
St. Louis, MO 63141  
(800)325-1485  
(314)432-6106

CIRCLE 748 ON READER  
SERVICE CARD

## Textra

A word processing program featuring block copy and move, global search and replace, wordwrap, and merge from file, and which allows text from one file to be copied into the file being edited. Characters can be inserted by simply positioning cursor and typing, without the need to enter a special insert mode. Six delete functions are available, as are 21 cursor movements controllable from the keyboard.

Other features include paragraph reformatting, line shifting and centering, and definable margins. Printing functions include automatic pagination, headers and footers, and single sheet operations. (List Price: \$70; demo disk only \$10)

**Requires:** 64K, one disk drive, PC-DOS, monitor. Ann Arbor Software Assocs.  
407 N. Main  
Ann Arbor, MI 48104  
(313)769-9088

CIRCLE 716 ON READER  
SERVICE CARD

## Church Donations

A program to automate recordkeeping for churches with up to 2,000 members. It allows for entry of names, addresses, pledge envelope numbers, telephone numbers, a 3-character select code, comments, 0-to-4 pledge amounts, and 1-to-15 user-defined categories of data for each member of a church's congregation.

Church Donations can produce quarterly reports, a complete or selective list of the congregation, mailing labels for all or selected members, grand totals of contributions to date, and totals to date by individual or offering category. (List Price: \$275)

**Requires:** 64K, two disk drives, PC-DOS, monitor. Custom Data  
P.O. Box 1066  
Alamogordo, NM 88310  
(505)434-1096

CIRCLE 749 ON READER  
SERVICE CARD

## BLUE Word Processor

A color, multi-window word processing program that allows a user to edit up to eight files in up to eight windows simultaneously. Each window's color is user-definable.

The program provides formatting features for structured documents, and includes standard word processor features plus footnotes, keystroke macros, format macros, and hyphenation. BLUE Word Processor can support printer capabilities such as proportional spacing, micro-justification, underlining, italics, boldface, as well as sub- and superscript. The program allows user modifications as needed, and uses standard DOS files. (List Price: \$150; manual alone \$35)

**Requires:** 64K, one disk drive, PC-DOS 1.1 or 2.0, color/graphics or monochrome adapter, monitor. Symmetric Software Inc.  
1805 Clemson St.  
San Bernardino, CA 92407  
(714)887-8595

CIRCLE 741 ON READER  
SERVICE CARD





The Agency Manager, Applied Systems

## THE AGENCY MANAGER

An integrated insurance agency management package for the PC-XT, featuring programs to handle customer accounting, general ledger, client data updates and file retrievals, over 100 different marketing reports and sales presentations aids, word processing, telecommunications capabilities, utilities, and ACORD forms.

The Agency Manager allows the user to automate the operations of an insurance agency, with the optional capability of linking via telecommunications to insurance data networks, such as the Insurance Value Added Network System (IVANS). The Agency Manager includes WordStar and MailMerge programs. (List Price: \$3,750, including WordStar and MailMerge) **Requires:** PC/XT; 128K, PC-DOS 2.0, monitor, printer. Applied Systems Pauling Rd. Monee, IL 60449 (312)534-5575

CIRCLE 750 ON READER SERVICE CARD

## Micro-Mail

An electronic mail system (E.M.S.) using microcomputers which do not need to be dedicated solely to the E.M.S. function. The system is menu-driven, and users can choose to either set their systems to send/receive messages and data as needed or overnight in automatic mode. The system can automatically dial each site at predetermined times, exchange messages, or hold messages until the receiver is ready to receive. (List Price: \$500 per site for first four stations; \$400 for station five; \$300 for station six; \$200 for stations seven and up)

**Requires:** Each Station: 256K Quadboard, two disk drives, PC-DOS 1.1 or CP/M-86, async port, modem, word processing software. Warner Computer Systems, Inc.

52 Woodbine St.  
Bergenfield, NJ 07621  
(201)385-8900  
(212)395-3395

CIRCLE 743 ON READER SERVICE CARD

## MICROCRYPT

A file encryption utility providing the user with a means to protect software files and transfers of data over phone lines. Encryption keywords are created by the user for each file. Only by using these keywords can the file be unlocked. MICROCRYPT also features Encrypted file viewing, which allows the user to examine the contents of an encrypted file without permanently decrypting the file. (List Price: \$95)

**Requires:** 64K, one disk drive, PC-DOS or CP/M-86. Sextant Systems  
P.O. Box 251  
Holmdel, NJ 07733  
(201)671-7670

CIRCLE 746 ON READER SERVICE CARD

# New On The Market

## Business Accounting Control System

An accounting software package consisting of five programs which can be used separately or in unison. The programs—Order Entry/Inventory Control, Accounts Receivable, Accounts Payable, Payroll, and General Ledger—feature screen access to management reports, a screen capacity of up to 132 characters (with appropriate hardware), error checking, and controlled audit trails.

Written in RM COBOL, the Business Accounting Control System can operate under an extensive range of operating systems, including CP/M-86, PC-DOS, TURBO-DOS, UNIX, and XENIX.

(List Price: \$1,000-\$1,500 each module)

**Requires:** 64K, one hard disk, 132-column monitor, printer.

American Business Systems, Inc.

3 Littleton Rd.  
Westford, MA 01886  
(617)692-2600

CIRCLE 719 ON READER  
SERVICE CARD

## QUESTEXT III

A general purpose textual information control program, incorporating word processing and database management capabilities. The program imposes tree-like menu structures on entered text without need for programming or debugging.

QUESTEXT III allows up to 32,700 records, and up to 6,000 screens are possible. Menus can be up to 99 lines each. Categories and subcategories created by the user can be phrased in English, without abstract coding or keywords, and are shown on-screen in English—data structures imposed by the program are invisible to the user.

A mini version is available, allowing 6 lines per menu, up to 40 screens, and up to 500 records. (List Price: Full version \$299.95; mini version \$49.95; manual only \$29.95)

**Requires:** 96K, two disk drives, PC-DOS, 80-column monitor.

Information Reduction Research

1538 Main St.  
Concord, MA 01742  
(617)369-5719

CIRCLE 714 ON READER  
SERVICE CARD

## DEMI-PLAN Project Management System

A project scheduling/management program allowing the user to define and maintain a file of project tasks and resources. This information is used to print various forms of Gantt charts, resource histograms, and task/resource cross-reference printouts. The program determines the critical path of a project and allows the project manager to introduce "what if" data to show the effect of data and resource changes on a project's completion date. (List Price: \$74)

**Requires:** 128K, one disk drive, PC-DOS, monitor, printer.

DEMI-Software

6 Lee Rd.

Medfield, MA 02052

(617)359-4502

CIRCLE 756 ON READER  
SERVICE CARD

## PCNC

A manual programming assist package for Numerical Control (NC) machine tools. PCNC includes a full-function text editor for generating NC programs, and an adaptive backplotting system that can simulate a variety of machine tools. Machine-specific cycle times analysis can predict cutting times. An automatic disk file management system with RS-232 I/O permits DNC operation. (List Price: \$1,495)

**Requires:** 128K, one 320K disk drive, graphics monitor, color/graphics card, RS-232 tape punch/reader.

Suburban Machinery Inc.  
Software Div.

37127 Ben Hur Ave.  
Willoughby, OH 44094  
(216)951-8974

CIRCLE 751 ON READER  
SERVICE CARD

Questext III, Information Reduction Research





### Health Risk Analysis

A program allowing the user to evaluate future life expectancy based upon entered vital statistics, personal habits, past medical history, family medical history, health practices, occupation, and other factors. Using recent Health Risk Tables, Height-Weight guidelines, major medical association health recommendations, occupational safety information, and American Cancer Society suggestions, the program analyzes an individual's risk factors, calculates probable life expectancy, then makes concrete suggestions for improving longevity through modification of personal health practices.

(List Price: Personal Version \$59.50; Professional Version \$259.50)

**Requires:** 64K, one disk drive, PC-DOS, monitor.  
The Center For Medical Microcomputing  
P.O. Box 9615  
Madison, WI 53715

CIRCLE 731 ON READER  
SERVICE CARD

### AMI Accounting Package

A menu-driven accounting package consisting of General Ledger, Accounts Receivable, Accounts Payable, and Payroll. The maximum number of ledger and sub-ledger accounts, cost centers, transactions posting cycles, vendors, employees, etc., that can be handled by the programs is limited only by user's disk capacity.

General Ledger offers a chart of accounts with sub-ledger capability and cost center reporting. Past period adjusting entries can be processed for any period in the current year. Accounts Receivable allows open item or balance forward methods of accounting. It allows for automatic aging with various categories, accepts partial payments, and prints statements selectively by customer.

Accounts Payable can operate on a cash or accrual basis. Each invoice can be distributed to cost centers, due dates can be calculated automatically, and partial payments can be made through the program. The program also allows for flexible payment selection by due date, vendor, and/or specific invoices.

The Payroll program processes hourly, weekly, bi-weekly, semi-monthly, monthly, bonus, and com-



MicroRIM, Microrim, Inc.

mission pay types. It can compute regular, overtime, vacation, and sick leave wages, along with other wage options, and allows up to 10 deductions per employee. It can also calculate an employer's FICA, FUTA, and SUTA requirements.

(List Price: Complete Accounting package: \$1,795; components purchased separately: G/L \$675; A/R, A/P, and Payroll \$450 each)

**Requires:** 64K, two disk drives, MS-DOS.  
Automation Management  
5718 Westheimer, #410  
Houston, TX 77057  
(713)781-5941  
(713)781-5942

CIRCLE 727 ON READER  
SERVICE CARD

### MicroRIM

A relational database management program. MicroRIM provides data formats, querying capabilities, unlimited number of records or rows, 20 relations (logical files) per database, as well as screen editing and report writing abilities.

An optional Program Interface enables users developing applications software to reduce development time for software and to link together a group of applications to share a common database. (List Price: \$595; Program Interface \$395)  
**Requires:** 256K, two disk drives, PC-DOS.

Microrim Inc.  
1750 112th Ave. N.E.  
Bellevue, WA 98004  
(206) 453-6017

CIRCLE 729 ON READER  
SERVICE CARD

# New On The Market

## ENCHANTER

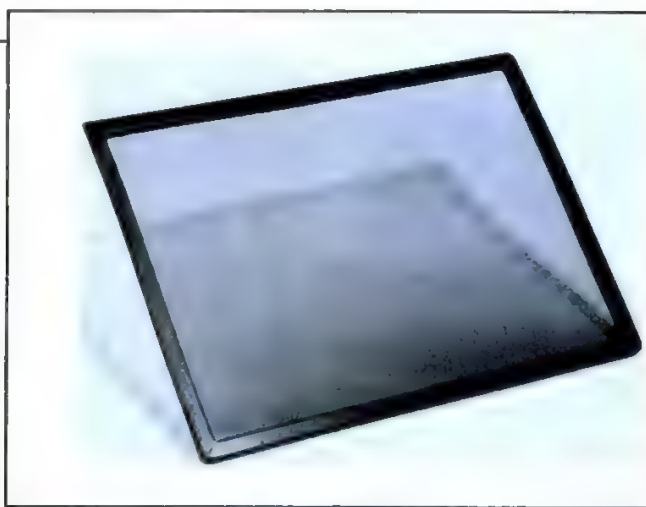
The first in a trilogy of related fantasy game programs. The player is pitted against Krill, an evil warlock whose ever-increasing powers have already wreaked havoc upon the world created by the program. The game's emphasis is on magic. Ultimately, skilled players will have mastered magic so effectively that they will be able to banish Krill forever.

ENCHANTER is written in INTERLOGIC, a proprietary programming system that enables players to communicate with the game in normal English. INTERLOGIC offers a vocabulary of 600 words, covering virtually every aspect of play. (List Price: \$49.95)

**Requires:** 48K, one disk drive, monitor.

Infocom, Inc.  
55 Wheeler St.  
Cambridge, MA 02138  
(617)492-1031

CIRCLE 736 ON READER  
SERVICE CARD



Anti-Glare Screen, Capitol Sales

## Pick That Tune

A game program containing 100 popular tunes divided into Pop, Country & Western, Children and TV categories. There are 16 game variations, and from one to ten players can play.

Players bid the number of notes they think they will need to identify a tune. Using a sound generator, the game program will begin with the lowest bidder and play the number of notes each player has bid until the tune has been picked or all players have missed.

Additional tune categories with 100 tunes are available separately. (List Price: \$29.95; additional 100 tunes \$9.95)

**Requires:** 64K, one disk drive, PC-DOS, Advanced BASIC.

Swearingen Software  
6312 W. Little York, #197  
Houston, TX 77088  
(713)937-6410

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## Financial Reporting System II (FRS-II)

A reduced-size version of the PDS Financial Reporting System, providing the user with a basic accounting system capable of producing general ledgers and financial statements. Users can at any time upgrade to the full Financial Reporting System without affecting stored data.

The full system allows for budget and last year comparisons, user-defined statement formats, as well as a link to Multiplan spreadsheets. (List Price: Basic system \$600 U.S.; \$750 Canadian)

**Requires:** 64K, two 320K drives, monitor, PC-DOS 1.1 or 2.0, 132-column printer. Prairie Data Systems, Inc.  
626 Broadway Ave. #202  
Saskatoon, Saskatchewan,  
S7N 1A9 Canada  
(306)384-7110

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## ACCESSORIES

### Anti-Glare Screen

A screen composed of a finely woven mesh of synthetic material that eliminates glare from display screens. The appearance of the display is altered so that characters appear on a dark background as opposed to a light one. Ambient light, not originating from the monitor, is kept from reflecting into the system user's eyes.

The screen fits into the recessed opening of the IBM CRT, and can be used for either monochrome or color monitors. (List Price: \$39.95)  
Capitol Sales Co.  
13740-J2 Research Blvd.  
Austin, TX 78750  
(800) 531-5255, ext. 804  
(800) 252-9146, in Tex.  
(512) 250-8757

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SERVICE CARD

### Video Screen and Plastic Cleaner

A cleaning solution formulated for electronics equipment, with anti-static and dust resistant properties. It will not harm glass or plastic. (List Price: \$5.00 pint-\$30 gallon)

Nu Look Products, Inc.  
P.O. Box 4678  
Hollywood, FL 33023  
(305) 981-9330

CIRCLE 764 ON READER  
SERVICE CARD



### UCC-4 Universal Charge Card Form

A universal charge card form that can be prepared automatically by a user's system and printed on any printer accepting a 9½-inch form. The forms are pre-printed with the scannable font consecutive numbers required by major credit card companies such as American Express.

The UCC-4 Form is a stock, off-the-shelf item, and is packaged 2,500 forms per carton. Special programming guides are available indicating print positions for either six-line/inch or eight-line/inch printouts. (List Price: 1-3 cartons \$95 each; 4 or more cartons \$85 each) CBI Corporation  
1164 N. Tower Ln.  
Bensenville, IL 60106  
(312) 860-2880

CIRCLE 766 ON READER SERVICE CARD

### Xidex Precision Flexible Disks

A line of 5¼-inch and 8-inch floppy disks, featuring a proprietary magnetic particle-coating formulation to achieve magnetic signal strength approximately 20 percent greater than industry average. The disks are packaged in an extra thick disk jacket for protection and durability.

(List Price: 5¼-inch disks \$4.50-\$7.50; 8-inch disks \$5.40-\$7.20)  
Xidex Corp.  
305 Soquel Way  
Sunnyvale, CA 94086  
(408) 739-4170

CIRCLE 763 ON READER SERVICE CARD

Precision Flexible Disks, Xidex Corp.



### Modular Computer Furniture

A new line of computer furniture that expands vertically as the user adds more hardware, peripherals and software. The modules have rounded edges and are furnished in Ashley Oak vinyl veneer with black matte vinyl accent panels.

The full line consists of a Desk (CT-130), Roll-About Table (CT-120), Hutch (CTA-131), and Monitor Platform (CTA-132). The desk will hold a monitor, keyboard, disk drive and printer. There is also a lockable security cabinet beneath the top. The 44 inch wide work surface has a rear-mounted safety retainer edge. Wire harness clips are attached to the back to organize equipment cords.

A coordinating hutch has an 11½-inch deep top book shelf with an access opening for cords. The interior shelves are adjustable and/or removable.

The Video Monitor Platform (CTA-132) can be used on either the Roll-About Table or Desk to make a self-contained computer center. (List Price: Desk \$169.95; Hutch \$99.95; Roll-About Table \$79.95; Video Monitor Platform \$17.95)  
Bush Industries, Inc.  
312 Fair Oak St.  
Little Valley, NY 14755

CIRCLE 767 ON READER SERVICE CARD



Modular Computer Furniture, Bush

### LABELWARE

A set of disk identifying labels in three types. Each package consists of the following:

56 1-inch × ½-inch rectangular tags including Master, Back Up, Copy, General Ledger, Payroll, Accounts Payable, Accounts Receivable, Spreadsheet, Database, Vol #\_\_, Version\_\_, Games, etc.

60 ¼-inch circular universal symbols for Keep Dry, This Way, No Smoking, No Magnets, No Touching.

8 4¼-inch × 1½-inch blank disk labels with universal warning symbols suitable for both 5¼-inch and 8-inch disks. (List Price: \$3.00)  
The D.P. Consultant  
P.O. Box 1174  
Plano, TX 75074  
(214) 596-0594

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# New On The Market

## PUBLICATIONS

### Public Domain Software

A library of public domain software, featuring 38 disks of programs for the IBM PC. The disks contain over 400 programs including a ram-disk, spooler, numerous games, utilities, spreadsheet templates and demos, as well as programs for modem communications, disk file maintenance, graphics, financial calculation, database retrieval, and education.

(List Price: Directory of available programs \$3.00; complete set of 38 disks \$80; a set of ten most popular disks \$50)

PC Software Interest Group  
1556 Halford Ave. #130P  
Santa Clara, CA 95051  
(408) 247-6303

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SERVICE CARD



### MicroSoftware Solutions

A catalog of microcomputer programs, books, accessories, and games. Featuring detailed descriptions of over 100 products in 22 formats, the catalog offers programs and books in Word Processing, Accounting, Time/Job Scheduling, Databases, File Management, Graphics, Real Estate, Tax Preparation, Electronic Spreadsheets, Medical/Legal Software, and Mailing List programs. (List Price: Free)

Career Aids/MicroSoftware Solutions  
8950 Lurline Ave.  
Chatsworth, CA 91311  
(213) 341-8279

CIRCLE 757 ON READER  
SERVICE CARD

### Applications Software Catalog

A catalog listing accounting and billing applications software, including receivables packages, general ledger programs, integrated accounting packages, and project management systems.

The catalog, designated Catalog B-53, lists programs by such professions and industries as job costing manufacturing, home building, and engineering consulting. (List Price: Free)

Monument Computer Service  
Village Data Center  
P.O. Box 603  
Joshua Tree, CA 92252  
(619) 365-6668

CIRCLE 759 ON READER  
SERVICE CARD

### U.P.S. Catalog

A 20-page brochure describing the power problems that can adversely affect computer installations, and how Uninterruptible Power Systems (U.P.S.) can eliminate them.

The brochure also includes detail specifications for Gould's line of 500 VAC to 45K VAC single and three-phase systems. Battery selection and application data is also provided. (List Price: Free)

Gould Inc., Power Conversion Div.  
2727 Kurtz St.  
San Diego, CA 92110  
(619) 291-4211

CIRCLE 760 ON READER  
SERVICE CARD

### Learning to Use the PC

A learning guide designed as a hands-on tutorial for the first-time user. It shows the user how to solve business problems, using examples that indicate what to expect when beginning to use the PC, what the user is doing right, what can go wrong, and how to correct inevitable mistakes. (List Price: \$14.95)

Q.E.D. Information Sciences, Inc.  
P.O. Box 181  
180 Linden St.  
Wellesley, MA 02181  
(617) 237-5656

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There is none. It's a simple matter of economics. Pegasus saw the growing need for mass storage, made a commitment to fill this need, purchased thousands of the finest quality hard disks, and is now passing the good deal along to you.

The only thing you may be missing in buying the Pegasus instead of the IBM XT expansion chassis is something you may not need in the first place: eight expansion slots, a communications card, three little initials, and an extra \$2,000 out of your pocket.

### What about support?

Pegasus and your dealer stand behind every Pegasus 10. If your unit requires maintenance anytime during the one year warranty, simply return it to your dealer for repair at no charge for parts or service.

### But don't I need a tape backup?

We recommend it! That's why we're offering you the

same great deal on a 1/4" cartridge tape backup. We've watched other companies offer 10 Mbytes of storage and forget about the backup altogether. Our tape backup, which carries a 90 day warranty, retails for just \$695 — a small price for over 25 Mbytes of formatted storage and lots of peace of mind.

### Where can I buy a Pegasus 10 Mbyte system?

Pegasus systems are available only through dealers. So contact the dealer in your area who sells IBM PC or compatible computers. If he doesn't have Pegasus, chances are he'll carry it soon. Just ask him to call us. We will ship him your Pegasus 10 immediately.

### Does Pegasus have larger storage systems?

Absolutely. 27, 65, and 140 Mbyte systems are soon available from Pegasus. And the best part is that they, too, are breaking new ground when it comes to pricing. If you've outgrown 10 Mbytes of storage, ask about the larger capacity units. All with the same top quality hardware and software and full one year warranty.

#### Shugart SA612 Hard Disk Specifications

12.95 Mbytes unformatted  
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92 msec access time average  
345 tracks/inch  
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power on hours

#### Cipher 525-CT Tape Drive Specifications

32 Mbytes unformatted  
28 Mbytes, 1024 byte sectors  
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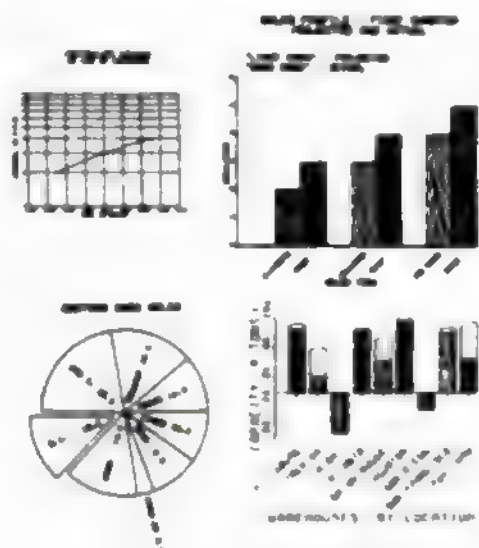
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## CLUB NEWS/EDITED BY SUSAN HURLEY

*Clubs, bulletin boards, and newsletters enable PC users to capitalize on their fellow users' knowledge.*

# PC User Groups

*This list provides the names and addresses of PC User Groups worldwide. You can check this list to locate other PC aficionados in your area.*

## ALABAMA

### Birmingham User Group

Chet Ellis  
ComputerLand  
215 W. Valley Ave.  
Birmingham, AL 35209  
(205) 942-8085

### The Greater Gulf Coast Users Group

Jim McGinnis  
124 Meadow Wood Loop  
Daphne, AL 36526  
(205) 626-9558

## ALASKA

### Anchorage User Group

Mark Bolzern  
c/o General Computer Services  
213 W. Sixth Ave., #11  
Anchorage, AK 99501

## ARIZONA

### The Phoenix IBM PC Users Group

Fred Linch  
P.O. Box 44218  
Phoenix, AZ 80564  
(602) 954-7519

### IBM PC User Group

Theresa Baudier  
P.O. Box 1489  
Tucson, AZ 85701  
(602) 622-4751

### Phoenix IBM-PC Users Group

P.O. Box 44218  
Phoenix, AZ 85064  
(602) 954-7519

## CALIFORNIA

### Sacramento IBM PC Users' Group

2844 Wright St., #135  
Sacramento, CA 95825

### IBM PC Users Group of

Santa Maria  
Ray Smyer  
575 Ferndale Dr.  
Santa Maria, CA 93455  
(805) 937-7490

### San Diego IBM User Group

Michele Albright  
4005 Isle Dr.  
Carlsbad, CA 92008  
(714) 434-1608

### Stanford/Palo Alto User Group

Linda de Sosa  
P.O. Box 8292  
Stanford, CA 94305  
(415) 856-6281

### San Diego Computer Society

John Field  
1384 Caliente Loop  
Chula Vista, CA 92010  
(714) 421-9686

### IBM PC User Group

Lee Wersel  
7255 Orchard Dr.  
Gilroy, CA 95020

### Beach Cities IBM PC Users Group

Phil Root  
6242 Moonfield Dr.  
Huntington Beach, CA 92648  
(714) 847-6369

### Modesto-Turlock PC User Group

Liz Leedom  
Box 1122  
Modesto, CA 95353  
(209) 523-4218  
(209) 578-2358

PC will publish a periodic listing of PC user groups and their activities. Drop a line to Club News, PC, One Park Ave., New York, NY 10016. New groups and address changes are shown in boldface.



PC MAGAZINE 617 SEPTEMBER 1983

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CompuServe:  
 Mike Todd, 70001,1264  
 Wes Meier, 70215, 1017

Financial Institutions Users Group of the  
 D.C. Metropolitan Area  
 Gary Eiserman  
 First American Bank, N.A.  
 740 15th St., N.W.  
 Washington, D.C. 20003

## FLORIDA

IBM Personal Computer Users' Group  
 Wyatt Bell  
 The College of Boca Raton  
 3601 N. Military Trail  
 Boca Raton, FL 33431

Manasota IBM-PC User's Group  
 Richard Reynolds  
 1102 Mallorca Dr.  
 Bradenton, FL 33529  
 (813) 792-5400

## GEORGIA

Atlanta IBM PC SIG  
 P.O. Box 76516  
 Atlanta, GA 30358

## HAWAII

Honolulu IBM PC Users Group  
 Doug Long  
 P.O. Box 22967  
 Honolulu, HI 96822

## IDAHO

Idaho PC User Group  
 Bruce Burns  
 ComputerLand  
 687 S. Capitol Blvd.  
 Boise, ID 83702  
 (208) 344-5545

## ILLINOIS

Autumn Chapter User Group  
 James L. Szafranski  
 5195 Castaway Ln.  
 Barrington, IL 60010  
 (312) 934-8133

## INDIANA

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 Susan Shields  
 ComputerLand  
 5450 N. Coldwater Rd.  
 Fort Wayne, IN 46825  
 (317) 259-7892

IBM PC Users Group, Inc.  
 P.O. Box 68271  
 Indianapolis, IN 46268

Northern Indiana IBM PC Users Group  
 Dr. Terry Alley  
 316 N. Ironwood Dr.  
 South Bend, IN 46615  
 (219) 289-5508

IBM PC User Club  
 Jo Spangler  
 Microbase Software, Inc.  
 P.O. Box 40353  
 Indianapolis, IN 46240  
 (317) 877-4304

South Bend PC Club  
 Thomas R. Lafree  
 19525 Cleveland Rd.  
 South Bend, IN 46637  
 (219) 277-3344

The North East Indiana IBM-PC Users  
 Group  
 9904 Goshen Rd.  
 Ft. Wayne, IN 46818

## IOWA

Cedar Falls User Group  
 Lee Ann Moore  
 Black Hawk Village Shopping Center  
 Cedar Falls, IA 50613

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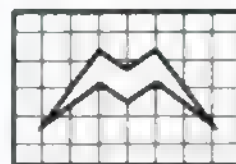
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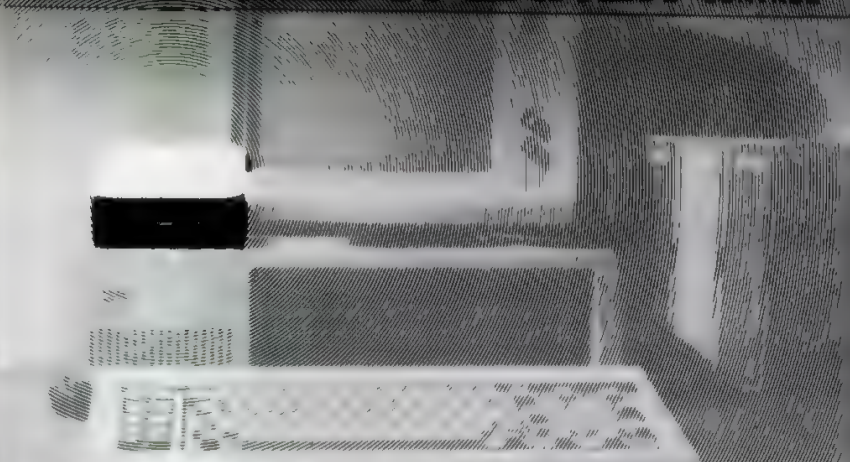
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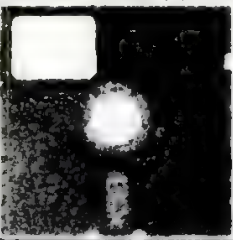
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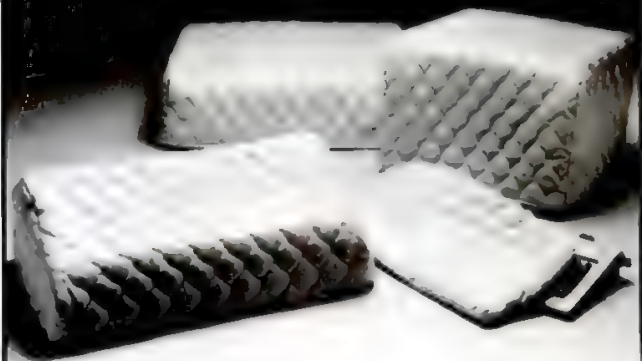
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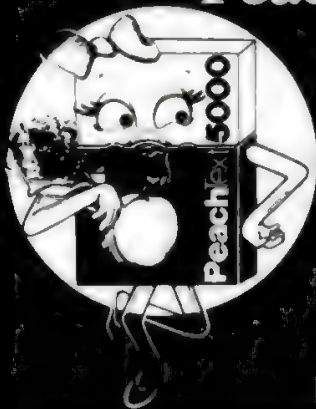
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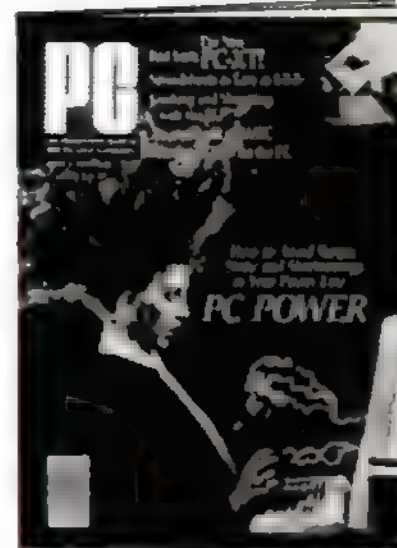




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*Are the PC's hardware and software good tools for software developers? The answers are yes and no.*

# Software Engineering And The PC

I'm living dangerously.

The presence of the term "software engineering" in my title might lead you to think that I know what it means. Well, I do have my own definition, but for the most part this term is used more widely than it is understood, even by computer scientists.

This is a big problem. My theory is (here I go out on another limb, watch out below) that, unlike the principles followed in the disciplines of civil, mechanical, and electrical engineering, the mathematics underlying software programming are not fully understood. I am certainly not suggesting that the other disciplines are closed, with nothing new to discover. My point is that the mathematical understanding of computers and software is still somewhat immature, while much of the known mathematics has not filtered

all the way up (or is it down?) to the practitioner's level.

A key word here is "discipline." Really good software developers, whether they exhibit any creativity or not, have a strong discipline of design and programming that they understand and to which they adhere rigidly. As a result, their systems tend to be thought out carefully; the software has provisions that can accommodate later thoughts or insights. Their programs tend to be carefully written, with built-in error checking, self-diagnostics, and checkout procedures. The resulting systems tend to have better, more intuitive human interfaces.

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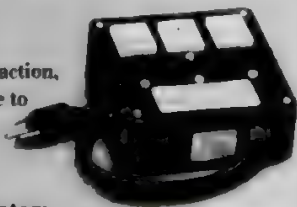
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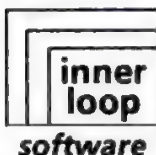
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gram development environment that they can get. The reason for this desire is their clear knowledge that a better working environment can save vast amounts of time in the software development process. Furthermore, a good environment is vital when more than one person is working on a project. The question is, how well does the IBM PC or XT serve as a programmer's

---

## ***T***HE OPERATING system defines the limitations of the total environment in a number of complicated ways.

---

workbench? The answer comes in two parts; dealing with IBM's hardware and software.

### **The Hardware**

The physical aspects of a good development system are easy to state. They have to do with capacity and performance.

First, the system needs to have adequate main memory. The IBM PC is up to this task; the 640K capacity of the system is more than enough for a single user. Assuming that the CPU is up to it, a multi-terminal system with 640K should support about four users. Installing 128K is an absolute necessity; this capacity is enough for most uses.

Next, the CPU itself needs to perform well. While much depends on the software in use, it is safe to say that a single user will have no problem with the IBM's performance. For multi-terminal use, the PC might be a little on the slow side due to the 8-bit data bus. Given the usual mix of program development work (lots of editing, with bursts of compiling and linking), a population of one to three terminals is practical. The use of an 8087 usually does not improve the development environment.

Third, disk capacity must be large. The 320K (or 360K) capacity of the IBM disk drives is small. Yes, it is possible to do productive work on a single, 160K disk-

ette system, but it is very inconvenient. Low mass storage capacity is a critical factor working against efficiency, so a disciplined professional programmer will always seek "adequate" capacity for the work in progress. A simple example: It is highly desirable to have the operating system, some utilities, the program editor, the language compiler, the linker, and all other commonly used tools instantly available. Fitting most full-function compilers on even a 360K capacity disk will be a squeeze. The 360K also shrinks quickly when a project's source, object, and executable files are all kept on one diskette, the preferred arrangement.

A single organized programmer working on a medium-sized project should find the standard PC with 256K of main memory and two 320K diskette drives to be manageable. The addition of a 10-megabyte hard disk is highly desirable and usually eliminates capacity problems, although it may make backup procedures more complicated.

Fourth, mass storage performance has a dramatic effect on total system throughput. Even if a diskette-based environment provides adequate capacity, the speed of data transfer can slow the overall operation. Hard disks usually offer better performance, although some have characteristics like the floppy drives. Electronic disks (portions of memory set aside to be treated as a disk) or cache schemes can help improve the performance of any configuration.

Finally, the choice of a printer is important. Here the developer must consider the amount of printing to be done and choose a printer that offers an appropriate throughput.

From these considerations, we can conclude that the XT is a good hardware environment for development, while the standard PC is adequate under certain circumstances. The use of an XT is somewhat hampered by the lack of adequate backup capability.

### **The Software**

The operating system, with its associated utilities and programs, is the most important factor to consider when building a development environment. The operating system defines the limitations of the total environment in a number of complicated ways.

First, the operating system must pro-

vide a powerful yet easy-to-use human interface. In this case, ease of use is determined by how the system meets the developer's needs. An appropriate interface might be confusing or obscure to a non-technical user since the professional may be willing to sacrifice some amenities in favor of greater flexibility. Nonetheless, the interface should work in a consistent fashion to reduce the amount of information that must be learned and remembered by the user.

Second, the system should provide the tools needed by the programmer to organize his or her work. Tools should also be available to help the programmer deal with the mass (or maze) of collected data.

An example might help to clarify what I mean here. Consider a system with PC-DOS 2.0, a hard disk, and a hierarchical directory structure (directories that can contain other files and directories, organized with an arbitrary number of levels of nesting). The programmer carefully organizes the data, but one day wishes to retrieve a particular file (let's call it FRED), one of about 400 files contained in 30 directories. PC-DOS 2.0 provides no direct way to find out where that file is! Yes, it is possible to give a TREE /F command, which can list all files in all directories, but then this list must be examined manually. Even the FIND command, which could search TREE's output to find "FRED," cannot associate it with its parent directory. Sounds trivial, doesn't it? But, for a professional it's more than a headache and it's wasteful of time.

---

## ***I***'M SCARED to death of a system that requires you to use a special utility to clean up the disk space.

---

Third, the utilities and tools provided by the system must be well integrated with themselves. PC-DOS 2.0 has the capability to "spool" text files to be printed. This allows the user to do something else while the printer is running, a feature referred to as background printing. But the



spooler is very limited. It can only handle 10 files, a very small number to a software developer. Control of the spooler is limited to the command level, so programs can-

## THE HARDWARE of the PC is suitable as a development work station.

not direct that printed output go through the spooler to the printer; instead, output must be directed to a file and be manually (or through a batch file) spooled with the PRINT command. In other words, this spooler is not an integral part of the system, but rather a simple utility of limited capability.

Finally, the software must be reliable. Do you know what the utility CHKDSK does? Most of us think of it as a utility to display how the disk is being used and how much space is left. A rarely stated purpose of CHKDSK is to recover space on the disk from files that had been changed or deleted. This space is "freed" and made available once again. Personally, I'm scared to death of a system that requires you to use a special utility to clean up the disk space. It makes me fear that some of my valuable data files might not be taken care of properly.

### The Bottom Line

I've said that the hardware of the PC is suitable as a development work station. You might infer from my comments above that also I think PC-DOS is somewhat lacking as a development environment. That's a fact. Worse, I think PC-DOS 2.0, for all its good features, does not much improve the situation.

Is there a better choice of operating system? Unfortunately not. Although a developer may choose to work in a better development environment, the fact of the matter is that the ultimate execution environment for PC software will be PC-DOS, because that is the one running on most machines. Any other system would support only its own execution environment, not PC-DOS.

I guess we'll just have to wait for PC-DOS 3.0 or 4.0 or ... /PC

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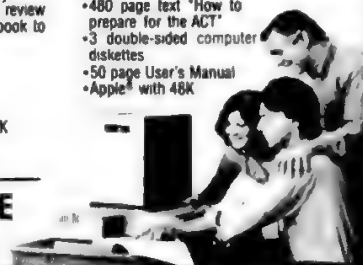
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### Freeware

An experimental method of distributing software: Authors make software available free of charge and ask for voluntary contributions from satisfied users. We take a look at how well this method works and review three programs available as Freeware: PC-Talk III, PC-FILE, and CHASM (the Cheap Assembler).

### DOS 2.0

Microsoft claims the PC's operating system is now a bridge to Xenix, but it still has more rivers to cross.

### IBM FORTRAN

What are some of the problems with the PC's version of this scientific programming language?

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## Coming Up



### Printer Roundup

A monster roundup of super dot-matrix printers. The Toshiba P1350, the Okidata 2410, the Prism-132, the Printek 920, the Anadex WP-6000, the OMNI 800, the DS-220, and more are reviewed in the October issue of PC.

### Goblins and Gremlins: PC Repairs

What's it like to walk into an office full of people crying and screaming about broken PCs? Hear it from the repairman's side.

And, when the lights don't glow, where do you go to get your PC fixed? Is IBM the only place?

### Confessions of a Programming Virgin

Writer Eric Freedman chronicles his first attempt at writing a program with minimal help from courses, books, friends, lovers, and strangers on the street.

### Good Grammar

Can you expect a piece of software to clean up your writing? Contributing editor Lindsay Van Gelder assesses some of the hopes and claims of the grammar checkers.

### A 24-Month-Old PC User

Canadian writer Marianne Paul tells the story of her 2-year-old word processor—who wears a different kind of software.

### Home Accounting Programs

The October issue profiles five more entrants into the burgeoning home accounting marketplace.

## How FORTH level 2 makes your PC 412% more powerful

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This is not a complete list and you may have questions not covered in this material — give us a call! We will address them and send you a brochure.

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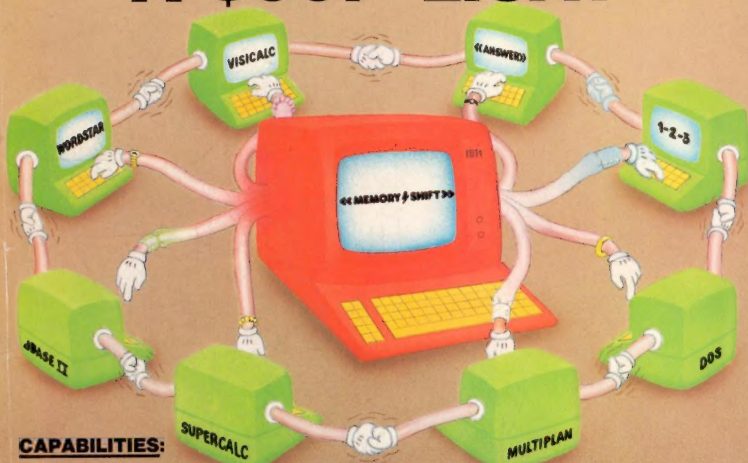
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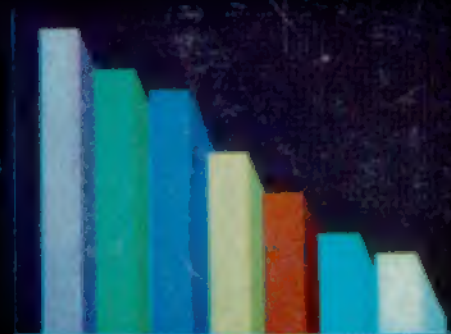
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